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THE RADIOSENSITIVITY OF TUMORS*

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IN CONSIDERING the radiosensitivity of tumors it is necessary to keep in mind that radiosensitivity is a relative term. The value of radiation therapy of tumors hinges on the margin between damage to neoplastic tissue and to normal tissue. The experience of the early workers in this field with radiation dermatitis[9] has taught us only too well the injury that may be done to normal tissue. It is understood, of course, that not only is the amount of radiation delivered important, but also the size of the field, the rate at which the radiation is delivered, and the time intervals between successive doses. The wave length, within the limits used therapeutically, is not a major factor as regards the biological effect or qualitative tissue response,[1] but is of importance from the standpoint of depth dosage. In my subsequent remarks, I shall assume the radiation to be delivered in accordance with usual therapeutic practice.

It would be unfair for me to continue without expressing my appreciation of the willing cooperation, patient help and sound advice of my radiologic colleagues.

Somewhat arbitrarily, I have considered the reactions of neoplasms to radiation to fall into three groups: radiosensitive tumors, which regress strikingly or disappear clinically with a total dose of 2,500 r or less of protracted radiation; radioresponsive tumors, which require from 2,500 to 5,000 r for similar regression; and radioresistant tumors, which require over 5,000 r for response. In the radiosensitive group, regression of the tumor will be obtained by doses that rarely cause appreciable damage to normal tissue; in the radioresponsive group, normal tissue in the field of radiation will show definite reaction but usually will recover without severe permanent injury; in the radioresistant group damage to normal tissue may equal or even exceed that done to the tumor.

As examples of the first group we may consider such tumors as the lymphomas, chronic leukemia, or Ewing's tumor of bone. In the second group fall such tumors as basal cell carcinoma of the skin, carcinoma of the cervix uteri, and adenocarcinoma of the thyroid. In the third group fall carcinoma of the stomach, carcinoma of the breast, malignant melanoma, and osteogenic sarcoma.

Radiosensitivity and radiocurability are not synonymous. Many tumors that regress strikingly with irradiation still go on to kill the patient. Even complete regression in the field of irradiation is of but little

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FIG. 1. Portion of skin showing marked radiation reaction.

value if metastasis beyond that field has occurred. Many tumors that can be cured by irradiation require a much greater dose for this result to be attained than they require for temporary regression.

Moreover, radiosensitivity is not necessarily a permanent, unchanging characteristic of a tumor. Fortunately, the metastasis of a tumor, itself of a resistant type, such as carcinoma of the breast, may regress or give definite relief from pain with a dose that falls in the range of that affecting radioresponsive tumors. You are all familiar with the symptomatic relief which may follow irradiation of a lumbar or femoral metastasis of carcinoma of the breast.

There is a marked tendency for recurrences to be more resistant to irradiation than was the initial tumor. This change in response may be due to greater resistance of the tumor cells that survived the initial irradiation, to the altered tumor bed, even to the condition of the patient, or more likely to a combination of these factors.

The regression of an irradiated tumor depends on changes in the supporting stroma, both the blood vessels and the connective tissue, as well as on destruction of tumor cells. Irradiation of cells, either normal or neoplastic, when grown in tissue culture, apart from their stroma, must be very heavy indeed, even over 100,000 r, to kill every cell. Therefore, the cure of a tumor by irradiation totalling say 4,800 r means that more has happened by direct irradiation than killing of the tumor cells alone.

If we consider what happens when an accessible tumor such as a basal cell carcinoma is irradiated, we find first cessation of mitosis in the tumor cells, then death of some of them, then changes in blood vessels, in some progressing to complete occlusion, as well as varying degrees of fibrosis and hyalinization of the connective tissue. These latter changes combine to impair the nutrition and hamper the spread of such tumor cells as may have survived the initial effect of the irradiation itself.

Thus radiosensitivity does not depend on the tumor alone, but is affected as well by the character of the supporting tissue, its degree of vascularity, and even by the presence or absence of infection. In general, fibrous tissue or muscle, with adequate blood supply and free from infection, forms the most favorable tumor bed for radiation therapy.

Conversely, bone, cartilage or fat makes a relatively unsatisfactory subtrate for irradiation of tumor tissue, as does the poorly vascularized and hyalinized tumor bed resulting from earlier irradiation.

While it may be said that, as a rule, less differentiated tumors are more radiosensitive, this is not completely correct. Indeed, our knowledge of the response of various tumors to irradiation rests largely on empirical grounds. It should be mentioned in passing that while histologic grading of malignancy is of some assistance in estimating radiosensitivity, many tumors of the higher grades are radioresistant, and some

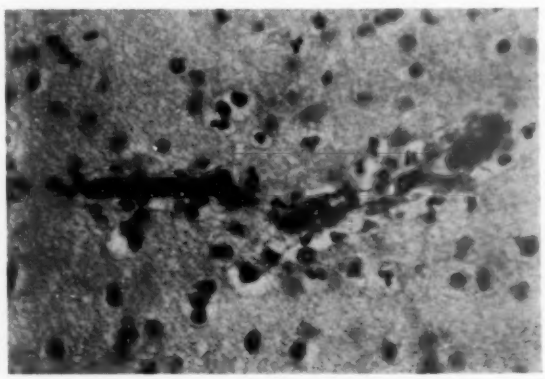

FIG. 2. Cerebral capillary showing hyaline thrombosis due to irradiation. ×400.

of the lower grades radiosensitive. Even with tumors of the same histologic type there may be variation in response, and even in the most resistant types an exceptional case may respond well to radiation therapy.

Reference should be made to the useful monograph of Stewart.[4] For me merely to catalogue the various tumors according to their degree of radiosensitivity would be of but little immediate value to you. Much more profitable will be the consideration of examples of different types of response, selecting among them some of those tumors concerning whose response to irradiation there is some disagreement.

As an example of a tumor that is radiosensitive, although rarely radiocurable, we may take chronic myelogenous leukemia. Here we have a generalized disease process involving practically all the tissues of the body, but particularly the hematopoietic system. The white blood cell count affords a ready means of following the progress of the disease and the effect of therapy. Since the disease is generalized, widespread irradiation in low dosage has been utilized by some. Others, stressing the involvement of the hematopoietic tissues, have felt that irradiation of the spleen or other involved foci may be effective. So sensitive to radiation is this tumor that suberythema doses of radiation, whether generalized or restricted to moderate-sized fields, will produce appreciable amelioration of the condition. While in the chronic forms of leukemia symptoms can be relieved and life can be prolonged by radiation therapy, in the acute forms therapy is as yet hardly worth while. Even in the chronic forms, cures are not anticipated. Here, then, we have the anomalous picture of an extremely radiosensitive tumor which is nonetheless rarely if ever radiocurable.

In the group of lymphomas, a rather heterogeneous group including such tumors as lymphosarcoma, reticulum cell sarcoma, and Hodgkin's disease, we have a somewhat comparable picture. In this group occasionally the prompt regression and remission of symptoms is the rule, but recurrence almost always develops soon. The subsequent responses to irradiation may be as satisfactory as the first, but usually are not. In this group, occasionally by the utilization of fairly heavy doses of radiation, long-term regressions and rare apparent cures may be obtained.

Fig. 3. Complete obliteration of artery due to late radiation reaction. ×30.

So radiosensitive are the tumors of the lymphoid group that at times their very responsiveness is a dangerous feature. The prompt development within a few hours of edema of irradiated lymph nodes may prove to be a fatal factor, particularly in the case of tracheobronchial nodes. Moreover, the degeneration products derived from the regression of a large mass of lymphoid tumor may prove toxic, occasionally even to the extent of producing death. In the case of the lymphocyte, a very primitive cell, we have an excellent example of the postulate of Bergonié and

Fig. 4. Late skin changes. Note hyalinization of stroma and telangiectasis. ×150.

Tribondeau that the more primitive cells are the most radiosensitive. While tumors of the lymphoma group may be localized at first, they usually become fairly well generalized. One unavoidable concomitant of irradiation of any generalized tumor is the irradiation of bone marrow. Unfortunately, the hematopoietic portions of bone marrow are those frequently adjacent to lymph nodes in need of irradiation. Consequently, the radiologist is hampered in carrying out as extensive therapy as he might desire by the undesired effects on the highly sensitive normal tissue of the hematopoietic portions of bone marrow.

In passing, I might mention that there appears to be no sound evidence for the statement sometimes made that the reticulum cell sarcoma is more resistant[3] to radiation therapy than are other forms of lymphoid tumors.

As examples of radioresponsive tumors we may take the basal cell carcinomas of the skin and the carcinomas of the larynx. The basal cell carcinomas of the skin cannot be diagnosed with any degree of accuracy clinically. Any appearance that they show may be simulated by epidermoid carcinoma. It is important to know with which tumor one is dealing; first, because of the somewhat greater radioresponsiveness of the basal cell than the epidermoid carcinoma; and secondly, because the basal cell carcinoma practically never metastasizes and the epidermoid carcinoma of the skin may metastasize. I have known of law suits arising because the patient had been assured on clinical grounds that the tumor was a basal cell carcinoma, would respond well to therapy, and would not metastasize, yet the tumor actually being epidermoid carcinoma formed metastases. Such a suit is apt to end with settlement or verdict for the plaintiff.

The carrying out of any radiation therapy without biopsy is a grave responsibility which should be very carefully weighed by a radiologist before undertaking it.

A word here might not be amiss regarding the choice of source of radiation in carcinoma of the skin. Many of the poor results that are obtained in the therapy of basal cell carcinoma (and these poor results are by no means rare) hinge on the utilization of surface application of radium or radon, thus killing off the superficial part of the tumor and permitting the continued development of the deeper portions. It is important to remember that skin cancer has depth as well as lateral extent. Roentgen therapy has great advantage here as the more even distribution in depth of irradiation afforded insures fairly similar response of different portions of the tumor. Interstitial use of radium or radon will accomplish the same end.

These basal cell cancers are not only radioresponsive but radiocurable. Most of the failures of radiation therapy that I have seen have been caused by one of two things —inadequate dosage or inadequate size of the field. This last is particularly important

to keep in mind as basal cell carcinomas not infrequently extend several millimeters beneath apparently intact skin.

One of the outstanding examples of tumors, both radioresponsive and radiocurable, is carcinoma of the cervix uteri. Here we have a tumor, often extensive when first seen, which fortunately metastasizes fairly late, and so leaves some period of time for local therapy. The combination of external irradiation and intracavitary application of radium or radon gives better results than does the surgical approach. In the great majority of cases radiation therapy is the standard procedure for cervical cancer. Here, although the tumor is radioresponsive, appreciable regressions being obtained with doses up to 4,800 r, nonetheless the proportion of cures is increased when the therapy is pushed beyond the radioresponsive zone up to a relatively heavy irradiation such as 6,400 or 7,200 r externally with 1,500 or 3,000 mc-hr. of intracavitary radiation.

Interestingly enough, some of the epidermoid carcinomas of the cervix uteri, indistinguishable clinically and pathologically from others, will not respond to irradiation satisfactorily. Those tumors which will not favorably respond cannot be determined in advance and usually the only way of identifying them early is to biopsy the tumor immediately following the first period of irradiation. If this is done, it is possible to pick out with a fair degree of accuracy those tumors that will fail to respond satisfactorily. This is shown by the failure of the tumor to show histologic evidence of radiation reaction.[8] Should such failure be apparent, treatment may be modified accordingly.

One point in need of further investigation is the occurrence of ureteral obstruction following radiation therapy, apparently without the presence of tumor and based on a reaction to irradiation of the ureteral tissues themselves.

The carcinomas of the larynx represent an interesting group of tumors. The carcinomas of this organ are in part radio-

Fig. 5. Enlarged spleen and liver due to myelogenic leukemia.

responsive and in part radioresistant. The choice between surgery or irradiation rests on two factors—the location of the tumor, on the one hand, and the grade of malignancy of the tumor, on the other. So far as the grade of malignancy is concerned, decision is relatively easy. Those tumors which are of Grade 1 and are relatively radioresistant should be operated upon if still localized. Those of higher grade will probably do better with irradiation than with surgery. From the standpoint of location of the tumor, irradiation is most successful in those carcinomas arising from the laryngeal vestibule and the smaller carcinomas of the cord which have not as yet impaired mobility. With regard to those of the cord, equally good or even better results will probably be obtained by surgery than by irradiation. Carcinoma in this organ thus well illustrates the fact that response to irradiation is influenced by other factors than the histologic make-up of the tumor alone. These tumors might well be regarded as radioresistant tumors as a dose of ap-

FIG. 6. Uterus showing necrosis following intracavitary irradiation.

proximately 7,000 r is required for satisfactory response.

The great advantage that radiation therapy offers as contrasted with surgery is that successful irradiation may restore completely the larynx from the functional standpoint. It is well to remember that often by the time half of the total dose of radiation has been given it may be possible, by noting the response or lack of response of the tumore, to determine whether further irradiation will be successful or whether the surgical approach should be resorted to. In the more advanced cases of carcinoma of the larynx, where the tumor is no longer intrinsic and hence the surgical approach unsatisfactory, radiation therapy may be of definite value although the probability of cure is not great in tumors of this type. In cases of carcinoma of the laryngeal vestibule, owing to their relative lack of differentiation and hence better response to irradiation, cures may be obtained even after the cervical lymph nodes have been involved.

Twenty-five to 30 per cent of cures may be expected with irradiation on the basis of published statistics.[2]

As one example of radioresistant tumors, I am selecting carcinoma of the breast. Practically all would agree that carcinoma of the breast is best treated primarily by surgery. However, carcinoma of the breast presents an interesting problem for the radiologist because here the questions of the value of preoperative and postoperative irradiation have not as yet been definitely settled. It is generally accepted that irradiation as primary therapy is unsatisfactory. Even when interstitial irradiation is used, the trend has been toward the surgical removal of at least the primary tumor. The only tumor in which irradiation is the method of choice is acute carcinosis, the so-called inflammatory carcinoma, and here irradiation is chosen not because of its good results, but because of the bad results of surgery in such cases.

It seems strange that in the years of argument as to the value of pre- and postoperative irradiation there has not as yet appeared any concrete evidence sufficiently convincing to settle the question definitely one way or the other. This is in part due to the changing techniques of irradiation, and in part due to varying criteria of operability, and in part to the inevitable irregularities of response always encountered in biological material.

If one applies to carcinoma of the breast the maximum amount of radiation tolerated by the normal tissues either externally by roentgen rays or by interstitial irradia-

FIG. 7. Carcinoma of the breast following heavy, extensive irradiation, illustrating persistence of tumor.

tion, the great majority will show a moderate regression, a few will be without perceptible change, and a few will show striking regression. In a few instances with combination of interstitial and external irradiation, I have seen complete regression of mammary carcinoma.

Preoperative irradiation of breast carcinoma has been recommended to destroy the more radiosensitive tumor cells and to damage the others. The statement that lymphatic channels are closed by preoperative irradiation of the type ordinarily given is not supported by evidence of changes in breast or other tissue following irradiation of the intensity usually given. On the unfavorable side one must consider that the period of irradiation necessarily consumes time and that further extent or even metastasis of the tumor may take place during this period. Of even greater practical importance is the fact that if doses sufficiently large to be effective were given, the carrying out of the necessary surgical procedures would be quite difficult and might prove dangerous to the patient.

The extremely high susceptibility of irradiated tissues to infection and necrosis should be kept in mind where irradiation is to be followed by surgery. Careful spacing of the time intervals between irradiation and surgical procedure is essential if untoward results are to be avoided.

Since in general carcinomas of the breast are radioresistant tumors, an appreciably heavy dosage must be given if prophylactic postoperative roentgen irradiation is to be of any value. This brings up the question as to whether or not the questionable presence of persisting tumor cells justifies the relatively severe damage done to the skin, chest wall, and possibly underlying lung.[6] If definite recurrences following surgery do develop, then postoperative irradiation is certainly indicated, but this, of course, would not be of the prophylactic type. It is to be remembered that usually death from cancer of the breast is due to metastases to the bones and/or viscera, rather than to local extension. That metastasis may occur from the local recurrence rather than from the primary tumor cannot be denied, but in the majority of instances the failures in treatment of cancer of the breast suggest that metastasis had occurred from the primary lesion rather than from later recurrences. If there is good reason to believe that complete surgical extirpation of the carcinoma and the regional lymph nodes has been carried out, there is no indication for local irradiation. If, on the other hand, disease has been left behind due to a greater extent than was realized when operation was begun, heavy irradiation should be given. One point to remember in this regard is that clinical examination of axillary lymph nodes is most unsatisfactory, as nodes involved by tumor may be not felt, and large, palpable nodes may owe their size to inflammatory hyperplasia rather than to metastasis.[5] Since the breast carcinoma cells are resistant to irradiation, it is necessary to give heavy doses if they are to be eradicated and this is not to be lightly undertaken in the absence of definite evidence of disease.

Fig. 8. Intrinsic carcinoma of the larynx (epidermoid). Radioresponsive.

FIG. 9. Polyposis of colon, precancerous.

I have already mentioned that metastases of carcinoma of the breast may respond favorably, at least temporarily, to moderate amounts of radiation. A great deal can be done to prolong and to make more comfortable the life of the patient by irradiation of metastatic deposits.

A word, at least in passing, should be given to the use of interstitial radium irradiation. I have seen several cases where marked regression of the tumor was obtained by the use of interstitial irradiation, and I have seen at least one case where there was no evidence of disease and the patient died of an unrelated lesion.

From the standpoint of the pathologist whose experience has been gained in the postmortem room as well as the operating room, I can see but little justification for irradiation of cancer of the breast except in the cases of acute carcinosis, so-called, in those cases where the lesion is judged to be inoperable, and for postoperative manifestation of the disease.

A word should also be said regarding irradiation of the ovaries in carcinoma of the breast. Occasionally striking regression of metastases of breast cancer will appear following ovarian irradiation and it is quite possible that in young women this procedure may be definitely helpful. After the menopause the value of such a procedure is extremely questionable.

It should be kept in mind that surgical extirpation of the ovaries in cancer of the breast had been tried, found wanting, and discarded as a therapeutic measure a generation ago. Whether the destruction of ovarian tissue by irradiation would be any more efficacious than by surgery still remains to be proved.

As an example of the completely radioresistant tumor, carcinoma of the stomach may be taken. It is particularly disappointing that carcinoma of this organ should be radioresistant because surgery still leaves much to be desired. The proportion of cures of carcinoma of the stomach is distressingly low. The degree of differentiation of gastric cancers, whether well differentiated and forming well defined glands or whether undifferentiated and merely forming infiltrating masses of epithelial cells, seems to make little difference. The dangers and discomforts to the patient of treating an organ adjacent to, and indeed partly overlapped by, the liver, outweighs rather nebulous hopes that such a tumor might prove to be radiosensitive. Even when a gastric tumor does prove to be radiosensitive, this very fact may be disastrous. I remember one instance where a lymphoma of the stomach responded so well to a dose of radiation that the tumor melted away leaving a gaping orifice in the stomach wall through which the contents poured into the peri-

toneum. While some favorable results in irradiation of the lymphomas of the stomach have been reported, they are no better than have been obtained by surgery.[7] From the standpoint of the radioresistance of the carcinomas and the possibly dangerous sensitivity of the lymphomas of the stomach, it would seem that this is a region that the therapeutic radiologist may well leave to the surgeon.

The carcinomas of the rectum and sigmoid are resistant, although at times response may be obtained. With the doses needed to produce clean-cut regression, radiation ulcers may be produced, and these may be so painful as to require resection of the involved bowel. Such evidence as may be obtained from pathologic study does not favor the use of irradiation when surgery is possible in this field.

As another example of a tumor usually radioresistant, I might cite the malignant melanoma of the skin. Here, while there may be temporary regression at the local site, usually as a result of changes in the tumor bed rather than in any appreciable change in tumor cells, the ultimate response is but very rarely satisfactory. In addition, irradiation of metastases is practically always without appreciable effect. A few cases of satisfactory radiation therapy of malignant melanoma have been reported. Some of these are authentic; others may be but are not supported by pathologic evidence. Moreover, this group of tumors is peculiarly treacherous, late appearance of metastatic deposits being of startling frequency. Five year cures of malignant melanoma mean less as regards the permanent health of the patient than of almost any other tumor.

In selecting this rather heterogeneous group of tumors for discussion, I have endeavored to point out some of the facts

Fig. 10. Rectum and anus. Removed because of painful ulcer following irradiation of carcinoma.

Fig. 11. Knee showing malignant melanoma. Radioresistant.

which have been established through your painstaking work over the years, and have also attempted to point out some of the points where further work is still urgently needed. That disagreement as to the therapeutic approach to some of our common malignant tumors exists is of utmost value in stimulating observation and experimentation that will enable us to do even more in the future for the patient suffering from cancer than we have been able to do in the past.

REFERENCES

1. Colwell, H. A. The Method of Action of Radium and X-rays on Living Tissues. Oxford University Press, London, 1935.
2. Cutler, M., Buschke, F., and Cantril, S. T. Cancer: Its Diagnosis and Treatment. W. B. Saunders Co., Philadelphia, 1938.
3. Krumbhaar, E. B. The lymphomatoid diseases (so-called lymphoblastomas). *J. Am. M. Ass.*, 1936, *106*, 286–291.
4. Stewart, F. W. Radiosensitivity of tumors. *Arch. Surg.*, 1933, *27*, 979–1064.
5. Taylor, G. W., and Bruce, H. H. Prognostic factors in carcinoma of the breast. *New England J. Med.*, 1940, *222*, 790–792.
6. Warren, S., and Gates, O. Radiation pneumonitis. *Arch. Path.*, 1940, *30*, 440–460.
7. Warren, S., and Lulenski, C. R. Primary solitary lymphoid tumors of the gastrointestinal tract. *Ann. Surg.* In press.
8. Warren, S., Meigs, J. V., Severance, A. O., and Jaffe, H. L. The significance of radiation reaction in carcinoma of the cervix uteri. *Surg., Gynec. & Obst.*, 1939, *69*, 645–647.
9. Wolbach, S. B. *J. Med. Research*, 1909, *21*, 415

COMMENTS ON THE TREATMENT AND SEQUELAE OF CARCINOMA OF THE UTERUS*

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IT IS not the purpose of this paper to present personal statistics nor to presume to add a new method to the treatment of cancer of the uterus, but to comment on and discuss various factors that enter into the success or failure of the methods employed in the treatment of the disease.

The urgent necessity of early diagnosis has been stressed as the most important factor in the successful treatment of cancer.

An attempt has been made by means of cancer propaganda and education of the laity to urge women who have borne children to have all chronic inflammations treated and lacerations repaired, as these conditions, in a majority of cases, precede cervical cancer. We have also stressed the fact that early cancers can be cured, and that periodical examinations are necessary to detect the disease in the curable stage.

Efforts at educating the laity emphasize a watery or bloody discharge as the first symptom of cancer of the uterus; but as there are usually no symptoms in the beginning of cervical cancer, greater stress must be laid upon periodical examinations, and the treatment of the conditions which may lead to cancer.

In over 90 per cent of women having cervical cancer, the disease is no longer in the early stage nor confined to the cervix when first examined, but some degree of invasion has occurred in the neighboring tissues. The success of any method of treatment will depend upon the extent of this invasion and its complete eradication.

Cancer of the cervix is classified according to the anatomical extent of the growth. The classification of Schmitz, or that of the League of Nations is generally used in most clinics.

Briefly, Schmitz's[14] classification is as follows:

Group I. The clearly localized growth.

Group II. The doubtfully localized growth.

Group III. The invasive growth.

Group IV. The fixed and disseminated tumor, including (a) the frozen pelvis, (b) invasion of vagina, bladder, and rectum, and (c) regional and distant metastases.

Schmitz reported that of 486 cases, when first seen at Mercy Hospital, about 7 per cent were in Group I, 13 per cent in Group II, 45 per cent in Group III, and 35 per cent in Group IV. Of the 97 patients, or 20 per cent, in Groups I and II, 55.67 per cent have survived the five year period with cessation of symptoms; of the 389 patients in Groups III and IV, which comprised 80 per cent of the entire number, only 11.15 per cent survived five years.

About 80 per cent of all cervical cancers fall into Groups III and IV. These are the advanced and almost hopeless cases which usually come to the radiologist for treatment.

EXTENSION OF THE DISEASE

The tumor may, by direct extension, invade the bladder, rectum, right or left parametrium and broad ligaments, body of the uterus, or the vagina.

Martin[10] describes the extension of cancer of the cervix as follows:

> The lateral extensions which occur early and produce no external evidence of their presence are, nevertheless, of great clinical importance. The tumor tissue probably travels outward along the fine lymphatics in the broad ligaments. Frequently, only one side is involved at first, although both sides may later show evidence of malignancy. The tumor tissue forms a dense band which extends from the cervix to the ilium and tends to rigidly fix the uterus in the pelvis.

When the parametrium is invaded, the ureters, which lie only about one-half inch

* Read at the Twenty-fifth Annual Meeting, American Radium Society, New York, N. Y., June 10–11, 1940.

lateral to the cervix, may become involved and become partially or completely occluded by pressure of the growth, or may be actually invaded by the disease. The bladder may be invaded before there is palpable evidence of the disease in the parametrium, and a cystoscopic examination should be made of all patients in Groups III and IV. Frequently, ureteral dilatation and hydronephrosis are present when the patient is first seen.

Cancer of the cervix also spreads into the lymph nodes and into the distant structures.

TYPE OF CELL

The study of the histological type of cell in cervical cancer has led to much discussion as to its radiocurability. That there is a difference in the radiosensitivity of the different types of cervical cancer is probable, but there is a difference of opinion as to which are the most favorable types. Most radiologists agree, however, that the histological type of cell is important, but that the most important factor, as far as prognosis is concerned, is always the extent of the disease.

Taylor[15] assembled the figures from four American and five German clinics on the curability by irradiation of different histological types of cervical cancer, including the three grades of adult, prickle cell, and spindle cell, and a fourth group of adenocarcinoma. He concluded that the differences between the cure rates in the four groups are scarcely significant, and that the histologic grade is of doubtful value in prognosis. The curability of adenocarcinoma, which is supposed to be radioresistant, is practically the same as the others. He also states that in 70 per cent of the primary cervical cancers, the iliac nodes which lie 7 to 12 cm. from the cervix are involved; therefore, a lethal dose must be given throughout the pelvis to points 7 to 12 cm. from the cervix, regardless of the type of tumor.

Several times in our own work we have seen the entire pelvis free of the disease after irradiation, but, when operated upon, tumor masses could be felt on the wall of the pelvis external to the peritoneum.

In regard to the radiation doses in the different histologic types, Schmitz[14] states:

> All authors recognize the necessity of applying large doses to the radioresistant carcinomas, the dosage varying from 4 to 12 threshold skin doses in the radioresistant, to 2.5 threshold skin doses in the radiosensitive cancers.

But, according to Taylor's figures, the curability of the different histological types differs very little. The most important fact is that the maximum number of erythema doses which the normal tissues will tolerate must be delivered to the primary growth and throughout the pelvis, regardless of the type of cell found.

Healy and Arneson[5] state that the best results in the primary lesion were obtained when a minimum dose of 6 to 8 T.E.D. was distributed throughout its volume, and Frazell[3] says that any method of radiation treatment that delivers less than 6 skin erythema doses to the parametrium will not control the disease in the majority of cases.

Healy and Arneson have done some valuable work on serial biopsies and the study of clinical results of cervical tumors following the administration of roentgen rays and before the radium is applied. They state that a larger percentage of cauliflower-like lesions showed good regression, i.e., shrinkage and contraction of the tumor, than did the infiltrated and cratered types. The serial biopsies did not show as much response to treatment as was observed clinically. The radiosensitivity of the local disease can be better estimated by clinical regression than by serial biopsy, and when this regression does not occur, the prognosis is not as good.

The total dose and the rate of administration of radiation also influence the degree and rapidity with which the tumor regresses. Healy and Arneson[5] state:

> It would seem advisable to employ some form of protracted treatment delivering a large total dose at a fairly rapid rate of administration over a moderately short period of time.

From different methods of external radiation employed, good histological regression occurred in the patients who were given 3.1 to 3.2 T.E.D. in a period of three weeks.

METHODS OF TREATMENT

Surgery has been practically discarded in the treatment of cancer of the cervix. A few surgeons still perform the radical Wertheim operation on patients in Group I, or possibly in Group II, but the death rate is high and the results are no better than those obtained by radium and roentgen irradiation. If surgery is used at all, it should be preceded by roentgen and radium irradiation; and roentgen irradiation should be given postoperatively.

A considerable portion of the operative mortality is due to peritonitis. If the operation is preceded by roentgen irradiation, the mortality from this cause will be markedly reduced.

The surgical viewpoint is well expressed by Morton[11] in an editorial in *Surgery, Gynecology and Obstetrics:*

> In 1913, articles in SURGERY, GYNECOLOGY, AND OBSTETRICS from the clinics of distinguished surgeons voiced the general feeling of the time when they stated that the greatest hope in treating carcinoma of the cervix uteri lay in wide excision of the primary growth. In 1938, just twenty-five years later, the bulk of evidence indicates without doubt that radiotherapy, with radium and the roentgen-ray in combination, gives far better results than radical surgery, now or at any time in the past.

RADIUM TREATMENT: METHODS AND DOSAGE

It is not within the scope of this paper to discuss the use of radium packs for the external treatment of the pelvis in uterine cancers.

Radium is used by practically all radiologists in the treatment of cervical cancer, but no uniform method of application of radium is used. The object is to give a massive dose to the cervix and the tissues adjacent to it, bearing in mind the danger to the bladder and the rectum. Radium is usually applied in the uterine and cervical canal and to the cervix by means of a colpostat or bomb. The colpostat probably delivers a greater dosage to the parametrium, and is especially desirable when the cervix is long and fibrous. In this type, the cervix may be pushed to one side and not be irradiated evenly by a vaginal bomb. Additional interstitial irradiation should be considered in this type of cervix, and should also be considered if the primary growth has not been brought under control. A few radiologists, however, use interstitial irradiation of the cervix and parametria routinely. The dosage in all cases must be estimated for the particular type of applicator used.

Some radiologists apply the radium in one intensive dose; others, in divided doses at weekly intervals; and others, in a continued weak dose of several days' duration.

The great advantage of giving the radium in interrupted doses is that, as the growth shrinks, more of the tumor will receive a heavier dose. If roentgen irradiation is given before the radium, most of the shrinkage will have occurred by the time the radium is applied. In this case, divided doses of radium are not necessary. The only other reason for giving radium in divided doses would be based on the assumption that it is an advantage to give the radiation at different stages of cell division or cell growth.

In treating superficial skin cancers by radium, however, we do not divide the radium dosage, but give it all in one stage.

Dean and Schmitz[14] state:

> The dose applied with radium inserted in the cervical canal, a single dose of 3,000 to 3,600 mg. el. hr. or a fractionated dose of 4,000 to 4,800 mg. el. hr. will give 3 T.S.D., about 2.5 cm. from the cervical canal. As the tolerance dose of the posterior mucosa of the urinary bladder is 3 T.S.D. and the wall is 2.5 cm. distant from the axis of the cervical canal, one must be careful not to injure this organ. If one gives a fractionated dose over a period of 15 to 18 days, the bladder can stand 4 to 4.5 T.S.D. (This includes the roentgen-ray dosage.)

Arneson and Quimby[1] state:

> Healy has repeatedly stressed the fact that when radium is applied to the cervix alone, it can be relied upon to control the disease directly in and about the primary lesion, but that it is incapable of destroying the tumor more than 3 or perhaps 4 cm. from the cervical canal.

The total dose given by Healy for the intrauterine applicator is 3,000 mc-hr.—1,000 in the uterine canal, and 2,000 in the cervical canal; 1,500 to 3,000 mc-hr. to the cervix or to one or both fornices by a bomb.

Lucas[9] states:

> Our hope for therapeutic efficiency lies between 5 to 10 T.S.E.D.

Apparently there is no uniformity of opinion as to the dosage of radium necessary in treating cancer of the cervix, or as to the measurements of the exact amounts delivered. It is probably safe to apply 3,000 to 3,600 mg-hr. in the average-sized uterus, and 2,000 to 3,600 mg-hr. in the vagina, if the bladder and rectum are carefully walled off by packing. It is desirable to give all the radium that can be safely applied without injury to the adjoining tissues.

The purpose of filtration is to remove all beta rays which do not penetrate, and do produce necrosis. According to Quimby,[12] 2 mm. of brass, 1 mm. of silver, 1 mm. of lead or 0.5 mm. of platinum or gold will remove all the beta rays. Additional filtration does not improve penetration, but does decrease the quantity of gamma rays. The inverse square law covering irradiation must always be taken into consideration, particularly in the use of vaginal bombs, if different sizes or types are used.

ROENTGEN TREATMENT

With the advent of 200 kv. machines, efforts were made to increase the dosage to the parametria and pelvic contents by means of roentgen rays.

At first, cross-firing of the cervix was stressed, and some still concentrate the dose on the center of the pelvis; but it is obvious that radium, properly applied, will successfully irradiate the cervix and the tissues immediately adjacent to it. In 70 to 80 per cent of the cases, however, the disease probably extends beyond this area (a radius of 3 to 4 cm. from the cervical canal).

The dosage delivered by radium is usually near the limit of toleration of the bladder and rectum. Consequently, many believe no further dosage by roentgen rays to this area is needed, and might be injurious, particularly if the radium dosage is unusually heavy.

Some years ago, reliance was placed on roentgen treatment of two large fields, anterior and posterior. Later, four fields were used, two anterior and two posterior, with a space of about 2 cm. between them; thus avoiding further direct irradiation of the cervix and tissues immediately adjacent to it. The rays are directed vertically to the outer parametria, and not angled toward the cervix. This method was further improved by two lateral fields which increase the dose to the outer portion of the pelvis, but add very little to the dosage received by the cervix, bladder, and rectum. Extreme care must be used when multiple or unusual portals are used (beyond the six portals described above) that the cross-firing does not produce dangerous overdosage due to overlapping of radiation in the deep tissues.

We do not care to discuss treatment with voltages of 400 to 1,000 kv. in this paper. It is probable that over 90 per cent of the cases of cancer of the cervix are treated with approximately 200 kv.

Practically no one advocates treatment of cancer of the cervix without the use of radium. Pelvic infections are generally present; and, if the roentgen treatments are given first (with small doses at the beginning if the patient is in poor condition), the infection will usually be brought under control before the radium is placed in the uterus.

While the fatalities from application of radium may run to 2 per cent, preceding the radium by roentgen therapy will reduce

this percentage to almost nothing. In addition, the size of the uterus and the growths in the vagina will decrease markedly, thus allowing a more even and thorough distribution of the radium dosage.

Arneson and Quimby[1] advocate the use of six fields, two anterior and two posterior over the pelvis, with a 2 cm. space between in the midline; each of these fields having a transverse diameter of 10 cm. and a longitudinal diameter of 15 cm., extending from the midline of the symphysis pubis to the iliac crests. The lateral fields should extend 15 cm. below the iliac crests, and, in most cases, 10 cm. wide. The lateral fields increase the dosage in the outer portion of the pelvis, but add very little to the dose received by the bladder and rectum. They state:

> An increase of the target-skin distance, from 50 to 70 cm., produces twice as much improvement in depth as the increase in filter from 0.5 to 2 mm. of copper, and only requires half as much increase in time.

They use 0.5 mm. of copper and 70 cm. distance. The rays are directed vertically to the fields, and not angled toward the center of the pelvis.

In different clinics, the *filtration* varies from 0.5 mm. of copper to 2 mm. of copper and aluminum. The *distance* varies from from 50 to 90 cm.

It is generally recognized that no field should be irradiated on successive days, but that each should be taken in turn. The daily dose over one area varies from 750 r to 200 r. If giving as much as 750 r daily, it probably is better to give the dose over two separate areas.

Skin Tolerance. Healy and Frazell[6] stated in 1937:

> A total of 1,500 r per portal can be tolerated without permanent skin damage if given over a period of 21 days.

Healy and Arneson[5] gave 2,000 r in three weeks and 2,400 r in four weeks to each of two anterior and two posterior fields.

Coutard[2] states that 2,500 r may be considered a maximum dose per field when the latter approaches 400 sq. cm. and should not be given in less than thirty days. The dose per seance for a field 400 sq. cm. does not exceed 200 r; for a field 300 sq. cm., it may reach 250 r. He uses 2 mm. of copper. Coutard also advocates many fields, treatments twice daily, skin distance 70 to 90 cm., and 3 to 5 r per minute measured on the skin.

Quimby[12] states:

> It is maintained by some radiologists that in order to obtain the best results, it is necessary for the fractional exposures to be administered at low intensity (3 to 5 r per minute), while others cannot see any advantage in this over high intensity (30 to 60 r per minute). This can only be settled by the treatment of large series of cases when the only variable is the r per minute. Quality, distance, size of port, type of lesion, must all be kept the same. From institutions where such series have been carried out, there appears to have been no evidence in favor of low intensity.

Our usual method of treatment of cancer of the cervix is as follows:

After taking a biopsy, we cauterize the base from which the specimen has been removed. Roentgen treatment is then given to two pelvic portals, anterior and posterior, each 20 cm. square, alternating the fields. One treatment is given daily. The area treated extends from the lower border of the pubic bone upward to the iliac crests. The rays are centered vertically to the skin. We use 50 cm. distance, 200 kv. constant potential, 5 ma., 1 mm. of copper and 1 mm. of aluminum filter, half-value layer 1.43 mm. copper; delivering 14.6 r per minute, corrected for barometric pressure; total dosage daily, about 215 r. An average-sized patient receives 1,300 r over each portal in fourteen days, as treatment is not given on Sundays.

Within four days to one week, we apply radium in the intrauterine applicator. Usually 100 mg., distributed in 5 mg. needles, is used. These needles are placed in the applicator in four sections, with four needles on the outside and one in the center in each section. Filtration is 1 mm. of plati-

num and 1 mm. of aluminum. The radium usually remains in place for thirty-six hours or a total dosage of 3,600 mg-hr. Three or four days later, a vaginal bomb containing 100 mg. of radium is placed in the vaginal canal against the cervix, for twenty-four to thirty-six hours. The filtration is 1 mm. of lead, at a distance of 1 cm.

A second series of roentgen treatments, as described above, is given, starting eight weeks after the beginning of the first treatment.

Rather severe skin reactions follow the roentgen treatment, but no permanent harm is done. Aquaphor ointment, as recommended by Kaplan and Rubenfeld,[8] usually controls the pain and irritation. Diarrhea, but no bloody stools, occurs toward the end of each series of treatments. The diarrhea is controlled by milk diet and paregoric. Radiation sickness is not severe in most of the cases treated. Usually there is some irritation of the bladder.

We have not been able to discover any permanent injury to the bladder or bowels, nor any obstruction of the ureters due to irradiation.

We vary the method, as described, in cases of very obese women, as the skin will not tolerate the amount of radiation necessary to deliver sufficient dosage to the pelvis.

We add two lateral fields in obese cases. In addition, we sometimes use pervaginal treatment with 50 cm. distance and 0.5 mm. copper, through cones 2 to 3.5 cm. in diameter. We seldom give over 3,600 mg-hr. of radium in the uterus unless the organ is very large, and then we do not give over 4,000 mg-hr. We occasionally give a third series of roentgen treatments, but seldom observe any good results from this series.

We have had recurrences in the outer wall of the pelvis, in the lumbar spine, and in areas throughout the body several years after irradiation, and still find the pelvis entirely free from the disease. We believe the addition of the lateral fields and a field over the lumbar vertebrae would decrease the number of these sequelae.

CANCER OF THE CORPUS

Classification of Endometrial Cancers.

According to Healy:[4]

Cancer of the corpus can be divided histologically into several subgroups. These are known as: (1) papillary adenoma malignum, (2) adenoma malignum, (3) adenocarcinoma, (4) solid cellular adenocarcinoma, (5) adenocanthoma, (6) epidermoid carcinoma. All, except the last group, represent some histological variety of glandular cancer. The proportion of recognizable glandular tissue is greatest in the first two and least in the fourth group. The degree of malignancy is least in the first two groups and greatest in the fourth group. The adenocanthoma variety represents a mixture of glandular and squamous tissues and varies considerably in its malignant qualities.

The diagnosis must be made by careful curettage of the entire uterine canal. Cancer of the body is associated with fibroids in a considerable number of cases, and one must not assume that because a fibroid is known to be present, there is no cancer of the fundus. The average age in which corpus cancer occurs is fifty-five years, generally postmenopausal, and has no relation to childbearing.

Cancer of the body of the uterus is more amenable to treatment either by surgery or irradiation than cancer of the cervix, because it is slow growing and metastasizes late in the disease.

When the uterus is larger than a two and one-half months pregnancy, the cure by either irradiation or surgery decreases markedly. The general outlook is unfavorable because of the duration of the disease and the extent of the involvement. The increased size of the uterus combined with the irregularity and length of the uterine canal makes it extremely difficult to deliver either a heavy or a uniform dosage of radium throughout the body of the uterus.

In the well-differentiated types of corpus cancer, and if the disease is limited to the body, surgery has given good results and a relatively high percentage of cures. In the anaplastic types of tumors, surgery will not give good results. At least 60 per cent of the cases with cancer of the body are operable,

judging by the extent of the lesion, but a large percentage of these are inoperable from the standpoint of the patient's general physical condition.

Direct extensions occur more frequently toward the cervix, and a complete hysterectomy should be done, unless the surgeon is absolutely sure that the disease has not extended to the cervix.

Sackett[13] gives the death rate from hysterectomy in his series as 3.2 per cent, but death from other causes made a total of 8.8 per cent in 68 operations, and an absolute five year survival rate of 42.6 per cent.

Heyman's[7] relative cure-rate from surgery alone is 50 per cent, 41 per cent from irradiation alone, and 55 per cent from the two methods combined. Obviously, however, the surgical group will contain a larger proportion of more favorable cases. Most of the patients who are too old, or are in poor physical condition, are apt to fall into the irradiation group.

The general tendency is to irradiate cancer of the body before operation. Roentgen treatment before curettage will decrease infection and reduce the size of the tumor growth. After curettage, radium is inserted into the uterine canal.

One gets the impression, when both irradiation and surgery are used in the treatment of cancer of the body, that neither is the surgery as complete, nor the irradiation as thorough, as if either method were relied upon alone. If the two methods, combined, were carried out meticulously, the end-results should be better than they are.

It is certain that thorough preoperative irradiation, both by means of roentgen rays and by radium, and postoperative roentgen treatment improve the operative results. It is desirable to reduce the size of the tumor by means of roentgen irradiation before the application of radium, and to give the intrauterine radium treatments in divided doses at weekly intervals to allow for shrinkage of the uterus.

Application of radium in the vagina should also be used if irradiation alone is to be relied upon. The radiation treatment must be as thorough as that used in cancer of the cervix.

SEQUELAE AND COMPLICATIONS

Invasion of the bladder walls with ulceration, sloughing, and formation of fistulae may occur in advanced cases. In our experience, fistulae are seldom due to faulty methods of irradiation, but to the extension of the disease. Constriction of the ureters, ureteral dilatation, and hydronephrosis are also generally due to the extension of the disease and not to over-irradiation.

A dull, nagging pain in the hips, groin, or radiating down the thigh or leg may be caused by some obstruction of the ureters. One must not assume, however, that all such pains are caused by obstruction of the ureters. A cystoscopic examination and visualization of the ureters should be performed in these cases. Similar symptoms are caused by extension of the disease to the lumbar and sacral nerves, and to the uterosacral ligaments.

Masses may form on the side walls of the pelvis by extension of the disease through the parametrium and broad ligaments, causing excruciating pain. Pressure on the veins of the lower extremities may result in edema of the lower limbs and external genitalia.

Invasion of the rectum may result in stenosis, ulceration, intestinal obstruction, and fistulae. These sequelae are rarely the fault of irradiation in experienced hands.

In the presence of low abdominal pain following radium application, patency of the cervical canal must be established by passing a uterine sound.

There may be cancerous tissue growing upward along the ureters behind the peritoneum. Involvement of abdominal organs and peritoneum may occur. Rarely, the disease spreads through the abdominal and thoracic nodes to the supraclavicular regions. Lungs, pleura, thyroid, and brain have all been involved. Metastases to the bones do not occur as often in cancer of the uterus as in other forms of cancer.

SUMMARY AND CONCLUSIONS

We have reviewed the problem of treatment of carcinoma of the uterus, covering types and extent of the disease, the dosages and methods of administration of radiation necessary to control it, and the best methods of distribution of these dosages.

We wish to emphasize the following points:

(1) Roentgen therapy should precede radium therapy. It reduces the infection, thus making safer the application of radium. It also reduces the size of the growth, rendering it possible to give a heavier dose of radium more evenly distributed throughout the tumor.

(2) If the roentgen therapy precedes the radium, it is not necessary to give the radium in divided doses, except in a very large uterus, especially in cancer of the body. Equally good results have been obtained by either method. Radium should be given in both the uterine and cervical canals in dosages just a little short of toleration of the surrounding tissues. As large a dose of radium as can safely be tolerated should be applied to the vault of the vagina by means of the bomb or colpostat, or by interstitial irradiation in selected cases.

(3) Roentgen therapy, by means of at least 300 kv., should be applied throughout the true pelvis, including its walls and extending as high as the crest of the ilium. This should be distributed as evenly as possible and given to the point of skin tolerance, rotating the fields. We believe the roentgen treatment should be repeated, beginning six weeks from the last day of the previous series of treatments; and we have seen no ill effects from repeating the roentgen dosage. In fact, we feel that a second series is absolutely necessary to give adequate dosage. Large fields will give a much heavier depth dose and a broader distribution in the pelvis. We have described our method of radiation treatment in detail.

(4) The sequelae and complications are usually only seen in very advanced cases.

(5) We believe that the addition of two lateral fields and another field over the lumbar vertebrae would minimize the extensions to the side walls of the pelvis and to the lumbar area, which are especially subject to extensions if the case is at all advanced.

REPORT OF CASES

CASE I. Mrs. M. T., aged fifty-five, no children. She was first examined October, 1939. She complained of a watery discharge since the previous January, with slight bleeding every three weeks since April. Menopause at the age of forty-seven. Her menses had always been regular, with one exception twenty-five years ago, when her period was delayed for five days. She had severe bleeding for one day, at this time, after a fall. Examination showed a large, retroflexed uterus which could not be dislodged. She had a profuse watery discharge, but no blood. The cervix appeared to be normal. Roentgen and radium treatments were advised for a probable carcinoma of the body of the uterus. A series of roentgen treatments was given (200 kv., 5 ma., 50 cm. distance, 1 mm. Cu plus 1 mm. Al filter) over two pelvic fields, 20×20 cm., a total of 1,314 r (in air) to each area in twelve days. One week later, a curettage was done and 100 mg. of radium was inserted in a vaginal bomb for forty-four hours. A second series of roentgen treatments as before was given in six weeks. The pathologist reported chorionepithelioma. This case is reported because of no history of pregnancy, and of the age of the patient when her first symptoms began.

CASE II. Mrs. E. J., aged fifty-eight, has had three children. This patient was first seen in December, 1932. She had lost a great deal of weight during the past year. She complained of discomfort in the bladder and frequent urination, and said she could feel a growth in the vagina which interfered with the taking of douches. She had a slight discharge, but no blood. Menstrual history was negative. Menopause occurred at the age of forty-eight. Upon examination, a large growth, almost filling the upper vagina, was found. This growth began on the anterior lip of a badly torn cervix. The uterus was enlarged and fixed in the pelvis, with marked thickening of the parametrium. Biopsy was taken and a diagnosis of squamous cell carcinoma (grade not given) was made. Eighty-five milligrams of radium was inserted in a vaginal bomb for twenty-four hours. Ten days later, 90 mg. of radium was inserted in the

uterine canal for thirty-seven hours. She was then given a series of roentgen treatments over two pelvic fields, 20×20 cm., 1,300 r over each area in twelve days. The treatment was repeated six weeks later. A third series of roentgen treatments was given the following year because of some bloody discharge. She was last examined in March, 1940, seven years after her first examination. There was marked atresia of the vagina, and at examination per rectum, the uterus was small and movable. There was no evidence of the disease, and the patient feels well.

Case III. Mrs. K. B., aged twenty-eight, no children. This patient was referred for treatment in February, 1939, after a previous biopsy. She gave a history of bleeding between menses and at intercourse for the past four or five months. She had a history of lues. Both tubes, one ovary, and a part of the other ovary had been removed two years before. Upon examination, there was a large cauliflower mass protruding from and involving both lips of a long, indurated cervix. She bled freely when examined. The uterus was fixed to the right side. A series of roentgen treatments was given in fourteen days, alternating over anterior and posterior pelvic fields, 20×20 cm., giving a total of 2,628 r (in air). A curettage was performed one week later, and 100 mg. of radium applied in the uterine canal for thirty-four hours. Ten days later, a vaginal bomb containing 100 mg. of radium was inserted for forty hours. Six weeks later, a second series of roentgen treatments was given as before. In September, she began to have severe pain in her back and hips. Roentgenograms taken of the pelvis and hips showed a small area of rarefaction on the intertrochanteric line of the right hip. An exploratory operation was done. The uterus and pelvic tissues appeared to be normal, but a mass could be felt external to the peritoneum on the pelvic wall. Later roentgenograms, taken at the hospital, showed an increasing rarefaction of the right hip and involvement of the left hip. The patient died in January, 1940, with general carcinomatosis. Metastases had occurred in the lumbar vertebrae, clavicle, and skull. The luetic condition no doubt had some bearing on the rapid spread of the disease. Diagnosis from a section of a mass above the clavicle was reported as medullary carcinoma.

Case IV. Miss R. G., aged thirty-two, weight 190 pounds. A supravaginal hysterectomy, with removal of adnexa, was done in 1931, for fibromyomata and ovarian cysts. In August, 1934, one week before coming for treatment, her surgeon did a biopsy. The pathologist reported squamous cell carcinoma of the cervix. Examination disclosed an ulcerating tumor mass involving both anterior and posterior lips of the cervix, and extending to the walls of the vagina. She had had a foul, bloody discharge for about six months. One hundred milligrams of radium was inserted in a vaginal bomb for forty hours. A few days later, roentgen treatment was begun. A total of 1,300 r was given to each of two pelvic fields, 20×20 cm., anteriorly and posteriorly, in twelve days. One week later, 45 mg. of radium was inserted in the cervical canal for forty-six hours. A second series of roentgen treatments was given eight weeks after the beginning of the first series. The patient did well, and the cervix healed. In October, 1939, five years later, she returned, complaining of sharp pain in the lower left pelvic area. Cystoscopic and proctoscopic examinations were performed, and no pathological lesion was found. She also had, at this time, a large gland above the clavicle. This gland was removed, and the pathologist reported metastatic transitional cell carcinoma, with squamous cell features (of possible cervical origin). No metastases to bones were found on roentgen examination. Roentgen treatments were given over the supraclavicular area, lateral pelvis, and lumbar and sacral regions, which afforded marked relief of pain for a few weeks. Later, in April, 1940, metastases were found in the bodies of transverse processes of the fourth and fifth lumbar vertebrae. Her pain was no doubt due to involvement of the lumbar nodes and vertebrae. No apparent disease could be found in the pelvis after five years, but metastases had occurred in the glands of the neck and to the vertebrae.

Case V. Mrs. L. F., colored, aged forty, one child born dead. Menstrual periods had always been regular. She had noticed a watery discharge for about a year before consulting her doctor. Menses suddenly stopped, followed by pain and watery discharge, but no hemorrhage. She had been losing weight, from 137 to 88 pounds. Her surgeon obtained a biopsy in March, 1934, and destroyed part of the cervix by means of cautery. The diagnosis was squamous cell carcinoma, Grade 2. This patient was referred to us for treatment eleven months later,

in February, 1935. At this time, she was complaining of severe pains in her back and legs, and soreness and burning in the rectum, together with severe vaginal bleeding during the past ten days. Examination disclosed a "frozen pelvis" with a sloughing, crateriform lesion extending into the uterus, the vagina, and to the rectum. A small rectal fistula was present. A large vaginal bomb containing 150 mg. of radium was applied for twenty hours. Roentgen treatment was begun immediately, using 20×20 cm. pelvic fields, anterior and posterior, 1,314 r being given over each area in twelve days. Following this series, 100 mg. of radium was inserted in a uterine applicator for thirty hours. Two months later, a second series of roentgen treatments was given. Examination in May, 1936, showed the cervix bound down toward the rectum, and the vagina shortened. Examination a few weeks ago did not reveal any apparent involvement of the pelvis. A small rectal fistula is still present. She is having no bleeding or discharge, is feeling well, and has gained weight. She is working every day.

This patient was apparently in Group IV, but is free of all symptoms of the disease five years after beginning treatment, and seven years after her first symptoms.*

REFERENCES

1. ARNESON, A. N., and QUIMBY, E. H. Distribution of roentgen radiation within the average female pelvis for different physical factors of irradiation. *Radiology*, 1935, *25*, 182–197.
2. COUTARD, H. Roentgen therapy of the pelvis in treatment of carcinoma of the cervix. AM. J. ROENTGENOL. & RAD. THERAPY, 1936, *36*, 603–609.
3. FRAZELL, E. L. Correlation of calculated tumor doses and five-year survivals in radiation therapy of cancer of the cervix. AM. J. ROENTGENOL. & RAD. THERAPY, 1938, *39*, 861–865.
4. HEALY, W. P. Radiation therapy of cancer of corpus uteri. In: Pack, G. T., and Livingston, E. M. Treatment of Cancer and Allied Diseases. 1940, *2*, 1638. P. B. Hoeber, Inc., New York.
5. HEALY, W. P., and ARNESON, A. N. A study of carcinoma of cervical stump developing after subtotal hysterectomy. *Am. J. Obst. & Gynec.*, 1935, *29*, 370–383.
6. HEALY, W. P., and FRAZELL, E. L. Methods and results of treatment in carcinoma of cervix at Memorial Hospital. *Am. J. Obst. & Gynec.*, 1937, *34*, 593–606.
7. HEYMAN, J. Radiumhemmet method of treatment and results in cancer of corpus of uterus. *J. Obst. & Gynaec. Brit. Emp.*, 1936, *43*, 655–666.
8. KAPLAN, I. I., and RUBENFELD, S. Use of aquaphor in irradiation epidermitis. *Radiology*, 1938, *31*, 107.
9. LUCAS, C. DEF. Calculation of dosage in radium treatment of carcinoma of the cervix. AM. J. ROENTGENOL. & RAD. THERAPY, 1936, *36*, 477–489.
10. MARTIN, C. L. In: Clinical Roentgen Therapy. E. A. Pohle, Editor, 1938, 308.
11. MORTON, C. B. Surgery and radiotherapy in the treatment of cancer. *Surg., Gynec. & Obst.*, 1938, *67*, 824–825.
12. QUIMBY, E. H. In: Pack, G. T., and Livingston, E. M. Treatment of Cancer and Allied Diseases. 1940, *1*, 144. P. B. Hoeber, Inc., New York.
13. SACKETT, N. B. Prognosis of cancer of the cervix treatment by irradiation. *New York State J. Med.*, 1935, *35*, 1153–1158.
14. SCHMITZ, HENRY. In: Davis. Gynecology and Obstetrics.
15. TAYLOR, H. C., Jr. Symposium: facts about x-ray and radium therapy; benign and malignant lesions of female reproductive tract. *Bull. New York Acad. Med.*, 1935, *11*, 368–382.

* For discussion see page 674.

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FAILURES FOLLOWING THE TREATMENT BY IRRADIATION OF CASES OF BENIGN UTERINE BLEEDING AND FIBROMYOMA*

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THE word "failures" is employed to indicate those cases in which radiotherapy failed to relieve the symptoms or to control the lesions for which it was applied together with those cases in which coincidental lesions, such as adnexal disease, might be neglected at the time when radiotherapy was given.

Since these failures, infrequent as they are, have been mostly due to errors in the selection of the case, in the calculation of dosages or an incomplete understanding of the effects of radiation and not to a failure of the principle underlying the method, it seems important to analyze them with a view to a better selection of cases and greater precision in dosage.

The principal contraindication to radiotherapy for these conditions is the menopause. This and the question of prophylactic excision of the pelvic organs are important factors in the treatment of uterine bleeding and myoma and should be the subject of intensive study but are not considered here.

Because benign uterine bleeding and myoma are so frequently associated and because the problems of the treatment of the two conditions are so intertwined, they will be considered together. The problem is not one of life and death as with cancer, but of administering that therapy which will be most effective in meeting the indications and least injurious to the patient. Table I is an attempt to present at a glance the entire picture. Across the top are the various types of treatment. At the side are listed the symptoms and conditions which require treatment together with headings which indicate the effect of the therapies on the patient and especially her reproductive function. The results of treatment are summarized by numbers 1, 2, 3, 4 in the order of excellence and −1, −2, −3, −4 to indicate ill effects. In an individual case one must determine the indications for therapy, estimate the effect of the therapy on the presenting condition and balance this against the injurious effects of the treatment. From this calculation will come the selection of the therapy most approrpiate for the case.

The material studied consisted of 733 cases suffering from uterine bleeding or myoma of the uterus in whom the immediate post-irradiation condition was recorded and whose progress had been followed for an average of eight years (2 to twenty-two). They include all types of myoma except those complicated by apparent adnexal disease, those which showed signs of acute degeneration and those in which the submucous tumor was pedunculated. About 25 per cent had a nodular uterine cavity indicating the presence of submucous myoma.

Considering the indications in the order given in Table I, bleeding is obviously the most important symptom whether it be due to abnormal functioning of the sexual cycle or to some local cause attributable to the fibroid. In the 733 cases bleeding was controlled by radium or roentgen irradiation in 719 cases (98.1 per cent), and uncontrolled in 14 (1.9 per cent). Table II gives the details of the immediate and late results following the various doses of radium and roentgen rays. For each type of therapy it is divided into three groups according to the size of the uterus: the first includes those up to the size of a two and one-half months' pregnancy; the second, those up to the size of a five months' pregnancy; and the last, uteri equal to or greater than the size of a six months' pregnancy. A further division is

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TABLE I

SUMMARY OF INDICATIONS, METHODS AND RESULTS IN BENIGN UTERINE BLEEDING AND MYOMA OF UTERUS

	Observation and General Treatment	Curettage	Myomectomy	Supravaginal Hysterectomy without Oophorectomy	Comp. Hysterectomy without Oophorectomy	Hysterectomy with Oophorectomy	Oophorectomy	Radium, Sterilizing	Radium, Partial Dose	Roentgen Ray Sterilizing	Roentgen Ray Partial Dose
I. Symptoms											
Bleeding	1	1	2	4	4	4	3	3	2	3	2
Dysmenorrhea	1	2	?	4	4	4	4	4	1	4	1
Molimena	1	1	?	4	4	4	4	4	2	4	2
Other pain	0	0	1	3	3	3	2	2	1	2	1
Urinary	0	0	?	3	3	3	2	2	1	2	1
Sterility	1	2	2	−4	−4	−4	−4	−4	1	−4	1
II. Pelvic Lesions											
Present											
Size of uterus	0	0	3	4	4	4	3	3	1	3	1
Degeneration	0	0	3	4	4	4	1	1	?	1	?
Chronic cervicitis	1	1	0	0	4	–	1	2	1	2	1
Sarcoma	0	0	0	0	1	1	0	0	0	0	0
Adnexa											
Inflammation	3	−1	−1	−1	−1	4	4	−1	−1	3	2
Ovarian tumors	0	0	0	0	0	4	4	0	0	0	0
Ovarian follicular cysts	1	0	0	−1	−1	4	4	4	1	4	1
Subsequent											
Degeneration	0	0	3	4	4	4	3	3	0	3	0
Cancer of corpus	0	0	0	4	4	4	1	1	0	1	0
Cancer of cervix	0	0	0	0	4	–	0	0	0	0	0
Sarcoma	0	0	1	3	4	–	0	0	0	0	0
Tumors of ovary	0	0	0	0	0	4	4	0	0	0	0
III. Effect of treatment											
Mortality	0	?	−3	−3	−4	−4	−2	−1	−1	0	0
Morbidity	0	−2	−4	−4	−4	−4	−4	−1	−1	−1	−1
Economic loss	0	−2	−4	−4	−4	−4	−4	−1	−1	−1	−1
Menopause											
Hot flashes	0	0	0	−2	−2	−4	−4	−4	−1	−4	−1
Nervous symptoms	0	0	−2	−2	−3	−2	−3	−3	−1	−3	−1
Libido	0	0	0	−1	−1	−3	−3	−3	−1	−3	−1
Sex characters	0	0	0	−1	−1	−2	−2	−2	0	−2	0
Present pregnancy	1	−4	−2	−4	−4	−4	−3	−4	−4	−4	−4
Future pregnancy	1	1	2	−4	−4	−4	−4	−4	−2	−4	−1

Numerals indicate degrees of good or bad effects.
4—Best possible result.
−4—Worst possible effect.
0—No effect.

made according to the age of the patient: up to the age of twenty-five, between twenty-five and thirty-eight, which is the active childbearing period, and above thirty-eight which is an age when a spontaneous menopause is not considered abnormal.

The doses of radium given in the left hand column were administered in 25 or 50

mg. tubes filtered by 0.5 or 1.0 mm. of platinum surrounded by a 1.0 mm. tube of rubber. This was inserted into the fundus of the uterine cavity.

"Old roentgen ray" indicates a form of therapy employed from 1912 to 1919. The lower abdomen was divided into nine fields about 4 cm. square. Through each of these and sometimes through a sacral and two sacrosciatic fields, a dose of 5 ma. for nine minutes was given and repeated after a rest of three weeks. Factors 100 kv., 4 mm. aluminum filter, 25 cm. spark gap, 25 cm. anode skin distance.

"Intermediate roentgen ray" indicates the employment of 200 kv., 0.5 mm. Cu filter, 50 cm. anode skin distance, one anterior and one posterior field 15×20 cm. Two exposures of 8 ma. for nine minutes were given to each field, one exposure every one to two days, producing a mild erythema. After 1932 dosages are expressed in roentgens.

The left half of the table gives the early results; the number of months required for the bleeding to cease, and the management and results in those cases in which bleeding continued. At the right are the late results; the interval after which bleeding recurred, and the results of subsequent treatment.

Failure to control bleeding, whether immediate or later, could in most cases be explained. It resulted mostly from miscalculation of the dose, whether this was simply a matter of milligram-hours or roentgens or, with radium, neglect of the law of inverse squares.

That underdosage at the original application was the cause of failure is demonstrated by those cases in which the bleeding was finally controlled by supplementary irradiation. Thirty, or 6.1 per cent, of 493 cases treated by radium and 18, or 7.6 per cent, of 240 cases treated by roentgen irradiation required subsequent irradiation to control the bleeding. This is illustrated in Table III

TABLE II(a)

UTERINE BLEEDING

Uteri in size up to that of a 2½ months' pregnancy

Age up to 25

	Immediate Results										Late Results								
Dose mg-hr.	Stopped after (mo.) 0	1	2	3	Continued Normal	Excess	Controlled No Rx	X-Ray	Radium	Hysterectomy	Recurred after (yr.) ½	1	3	5	Controlled No Rx	X-Ray	Radium	Hysterectomy	Satisfactory	Unsatisfactory
600	2	1			1	2	1		1	1	1	2			2		1		5	1
Total	2	1			1	2	1		1	1	1	2			2		1		5	1
Ages 25–38																				
600		1				2		1		1									2	1
1200	5	3	1		2	1	1	1		1		4	1		3	1	1		11	1
1800	14	8	2									2	2		3	1			24	0
2400	2					1				1									2	1
Total	21	12	3		2	4	1	2		3		6	3		6	2	1		39	3
Ages over 38																				
600	2	1	2	1		1		1				1					1		7	0
1200	45	33	8	2	1	1		1	1		1	8	2		7	4			90	0
1800	98	55	18	5	3		2	1			3	11	2	3	15	3		1	178	1
2400	33	15	3	1							1	2	2		4	1			52	0
3000	1	2																	3	0
Total	179	106	31	9	4	2	2	3	1		5	22	6	3	26	8	1	1	330	1
TOTAL	202	119	34	9	7	8	4	5	2	4	6	30	9	3	34	10	3	1	374	5

TABLE II(b)

UTERINE BLEEDING

Uteri in size from 2½–5 months' pregnancy

Age up to 25

Dose mg-hr.	Immediate Results: Stopped after (mo.) 0	1	2	3	Continued Normal	Excess	Controlled No Rx	X-Ray	Radium	Hysterectomy	Late Results: Recurred after (yr.) ½	1	3	5	Controlled No Rx	X-Ray	Radium	Hysterectomy	Satisfactory	Unsatisfactory
600	1										1				1				1	0
Total	1										1				1				1	0
Ages 25–38																				
600					1														1	0
1200	1	2		1	1	1	1			1		1		1	1			1	4	2
1800	2											1			1				2	0
2400		1																	1	0
Total	3	3		1	2	1	1			1		2		1	2			1	8	2
Ages over 38																				
600		1																	1	0
1200	15	7	4	3	2			2			4	2	1		5	2			31	0
1800	16	14	5	1		1				1		3			1	2			36	1
2400	9	5	5	1	1			1											21	0
Total	40	27	14	5	3	1		3		1	4	5	1		6	4			89	1
TOTAL 2½–5	44	30	14	6	5	2	1	3		2	5	7	1	1	9	4		1	98	3

TABLE II(c)

UTERINE BLEEDING

Uteri larger than that of a 6 months' pregnancy in women over 38

Dose mg-hr.	Immediate Results: Stopped after (mo.) 0	1	2	3	Continued Normal	Excess	Controlled No Rx	X-Ray	Radium	Hysterectomy	Late Results: Recurred after (yr.) ½	1	3	5	Controlled No Rx	X-Ray	Radium	Hysterectomy	Satisfactory	Unsatisfactory
1200	3	1	1			1				1									5	1
1800			1	1									1					1	1	1
2400	1	1			3			2		1		1				1			4	1
TOTAL over 6	4	2	2	1	3	1		2		2		1	1			1		1	10	3
GRAND TOTAL RADIUM	250	151	50	16	15	11	5	10	2	8	11	38	11	4	43	15	3	3	482	11

which is a condensation of that part of Table II which considers the radium treatment of small uteri. In these uteri, in women below the age of twenty-five, following 600 mg-hr. of radium, further irradiation was required to control bleeding in 33.3 per cent of the cases. In women twenty-five to thirty-eight years of age the same proportion received supplementary irradiation, and in women over thirty-eight, a slightly smaller number, 28.6 per cent. In women twenty-five to thirty-eight, 1,200 mg-hr. failed in 25 per cent of the cases and in women over thirty-eight in 6.7 per cent. In women twenty-five to thirty-eight receiving 1,800 mg-hr., 4.2 per cent required further irradi-

ation, and in women over thirty-eight 2.3 per cent. In one woman of thirty-six 2,400 mg-hr. failed to stop bleeding within six weeks. Hysterectomy at that time prevented a final appraisal of this dosage. In women over thirty-eight receiving this dose, 1.9 per cent required further irradiation. These variations in the dosage required conform with the general experience that younger women require larger doses.

In tumors up to that of a five months' pregnancy in size, still larger doses were necessary in the different age groups. For example, women over thirty-eight receiving doses of 1,200 mg-hr. required subsequent irradiation in 12.9 per cent of the cases as against 6.7 per cent for the smaller uteri; 1,800 mg-hr. failed at the first application in 5.5 per cent as contrasted with 2.3 per cent in the smaller tumors, and 2,400 mg-hr. failed in 4.7 per cent as contrasted with 1.9 per cent. The need for larger radium doses for the larger tumors is in many cases due to the lessened effect, according to the law of inverse squares, of the gamma rays on ovaries which are displaced by the tumor to a point distant from the radium.

Variations in the results following roentgen irradiation are not so striking. Although, compared with radium therapy, a

TABLE II(d)

UTERINE BLEEDING

Uteri in size up to that of a 2½ months' pregnancy

Age up to 25

	Immediate Results									Late Results								
Dose Roentgen Ray	Stopped after (mo.) 0	1	2	3	Continued Normal	Excess	Controlled No Rx	X-Ray	Radium	Hysterectomy	Recurred after (yr.) ½	1	3	5	Controlled No Rx	X-Ray	Radium	Hysterectomy	Satisfactory	Unsatisfactory
Old				1	1							1					1		2	0
Old substerilizing			1		3							1				1			4	0
Intermediate				1								1			1				1	0
Intermediate substerilizing			1										1			1			1	0
300 r					1														1	0
600 r	1												1		1				1	0
Total	1		2	2	5							3	2		2	2	1		10	0
Ages 25–38																				
Old	4	2																	6	0
Old substerilizing					1														1	0
Intermediate	2	5		1							1	1		1	1	1		1	8	1
Intermediate substerilizing	1	2	2		1						1	3			2		1	1	6	1
600 r		1									1				1				1	0
Total	7	10	2	1	2						3	4		1	4	1	1	2	22	2
Ages over 38																				
Old	14	7	6	4	2	1	1		2			3	1	3	5	2			34	0
Intermediate	21	22	4	1	2	1		1	1		1	1	1		3				51	0
Intermediate substerilizing		1	2								1	1			1	1			3	0
1200 r	7	11									1				1				18	0
1800 r	1	1																	2	0
Total	43	42	12	5	4	2	1	1	3		3	5	2	3	10	3			108	0
TOTAL SMALL	51	52	16	8	11	2	1	1	3		6	12	4	4	16	6	2	2	140	2

TABLE II(e)

UTERINE BLEEDING

Uteri in size from 2½–5 months' pregnancy

Ages 25–38

Dose Roentgen Ray	Immediate Results: Stopped after (mo.) 0	1	2	3	Continued Normal	Continued Excess	Controlled No Rx	Controlled X-Ray	Controlled Radium	Hysterectomy	Late Results: Recurred after (yr.) ½	1	3	5	Controlled No Rx	Controlled X-Ray	Controlled Radium	Hysterectomy	Satisfactory	Unsatisfactory
Old				1	1														2	0
Old substerilizing					1			1											1	0
Intermediate	5											1			1				5	0
1200 r		2										1			1				2	0
Total	5	2		1	2			1				2			2				10	0
Ages over 38																				
Old	9		3	2							1	1			2				14	0
Intermediate	12	11	2	3								1				1			28	0
1200 r	1	14	6	2	1			1				1			1				24	0
1800 r	1				2			1											3	0
Total	23	25	11	7	3			2			1	3			3	1			69	0
TOTAL 2½–5	28	27	11	8	5			3			1	5			5	1			79	0

higher proportion of cases required subsequent irradiation to control bleeding, these were almost all treated deliberately by substerilizing doses of roentgen rays. Most of these cases were treated before dosage was expressed in roentgens. Since the roentgen has been employed, fewer applications of substerilizing doses have been given because of improvement during this time in other methods of treating these cases and because of an increasing reluctance to irradiate women who later may bear children. Therefore, the number of cases is too small to be the basis of a generalization. However, it is our strong impression that in a woman under thirty, 300 roentgens anteriorly and 300 roentgens posteriorly will cause an amenorrhea for six to eight months which will be followed, with occasional exceptions, by a return of menstruation. This dose given to women of thirty-eight or more may cause a permanent menopause. Six hundred roentgens anteriorly and 600 roentgens posteriorly will sterilize most women over the age of thirty and occasionally women under that age.

Irradiation failed completely to control bleeding in 14 cases (1.9 per cent). Of these, 11 of 493 (2.2 per cent) followed radium treatment and 3 of 240 (1.2 per cent) roentgen therapy. Many of these were doubtless cases of underdosage but since they were not given further irradiation are classed as complete failures. The sequence of events and examination of the specimens removed allowed a reasonable inference as to the cause of the failure in 11 cases, leaving 3 in whom adequate dosage was given without controlling the bleeding, thus giving an unexplained percentage of failure of irradiation in 0.4 per cent of the cases.

Underdosage can be blamed for failure in 5 cases divided into (*a*) those who received originally a small dose of radium (2 cases) and of roentgen rays (1 case), and (*b*) underdosage because of the law of inverse squares, the cause of failure in 2 cases. One of these women, aged thirty-six, was treated with 1,200 mg-hr. in the cavity of a uterus the size of a four months' pregnancy. The enlargement was caused by a myoma in the left wall of the uterus so distorting the uterine cavity that the radium was separated from the left ovary by a distance of

12 cm. or more. If 1,200 mg-hr. was effective with normally disposed uterus and ovaries, 4,800 mg-hr. would have been required to destroy the follicles in the left ovary. Figure 1 is a diagrammatic presentation of this principle.

Because of this mechanism, in myomatous uteri of large size radium is not inserted into the uterus unless there is profuse bleeding. Sterilization is accomplished by roentgen therapy, the full sterilizing dose being given whether radium has been previously inserted or not. Further evidence of the importance of distance between radium and ovary is given by the number of failures in the uteri larger than a six months' pregnancy. Following radium there were 3 failures out of 13 cases and following roentgen irradiation, one out of 18 cases.

Four women were operated upon before the radium effect could be demonstrated; 2 after six weeks and 2 after eight weeks. Reference to Table II will show that even after heavy dosage, two and occasionally three

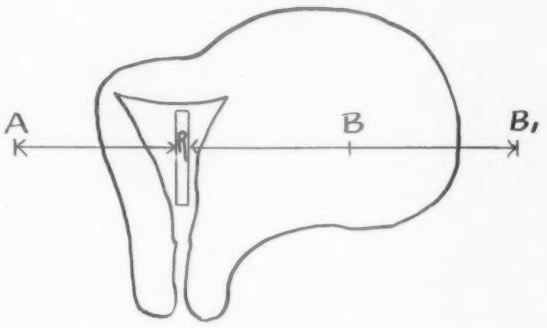

FIG. 1. *A* represents the position of the normal ovary. B_1 represents the position of an ovary displaced by a myoma from its normal position *B*. *R* represents a tube of radium in the center of the uterine cavity. Distance $R-B_1$ equals twice the distance $R-A$. Therefore according to the law of inverse squares, a dose of radium at *R* would have one-quarter the effect on B_1 that it would have on *A*.

TABLE II(f)

UTERINE BLEEDING

Uteri larger than that of a 6 months' pregnancy

Ages 25–38

Dose Roentgen Ray	Immediate Results: Stopped after (mo.) 0	1	2	3	Continued Normal	Continued Excess	Controlled No Rx	Controlled X-Ray	Controlled Radium	Hysterectomy	Late Results: Recurred after (yr.) ½	1	3	5	Controlled No Rx	Controlled X-Ray	Controlled Radium	Hysterectomy	Satisfactory	Unsatisfactory
Old			1																1	0
Intermediate	1																		1	0
Intermediate substerilizing	1										1					1			1	0
1200 r			1																1	0
Total	2		2								1					1			4	0
Ages over 38																				
Old	1	1			1														3	0
Intermediate substerilizing	1	1	2																4	0
900 r	1																		1	0
1200 r		3				1				1									4	1
2400 r	1			1								1				1			2	0
Total	4	5	2	1	1	1				1		1				1			14	1
TOTAL over 6 mo.	6	5	4	1	1	1				1	1	1				2			18	1
All Ages—All Sizes																				
GRAND TOTAL ROENTGEN RAYS	85	84	31	17	17	3	1	4	3	1	8	18	4	4	21	9	2	2	237	3

TABLE III

NUMBER OF PATIENTS TREATED BY RADIUM REQUIRING RE-IRRADIATION

Uteri in size up to that of a 2½ months' pregnancy

Ages up to 25

Dose mg-hr.	Immediate Control	Uncontrolled	Subsequent Irradiation	Total Cases	Re-irradiated Per Cent
600	3	1	2	6	33.3
Ages 25–38					
600	1	1	1	3	33.3
1200	8	1	3	12	25.0
1800	23	0	1	24	4.2
2400	2	1	0	3	0.0
Ages over 38					
600	5	0	2	7	28.6
1200	84	0	6	90	6.7
1800	173	1	4	178	2.3
2400	51	0	1	52	1.9
3000	3	0	0	3	0.0

months may be required for the full effect. From the standpoint of judging results, these cases are not properly to be considered as failures but, because an operation was performed and to draw attention to the necessity of waiting the proper length of time for the full effect of the irradiation, they are listed as such.

The only local condition which apparently caused failure was a pedunculated submucous myoma. In 2 such cases bleeding continued after adequate irradiation. Figure 2 shows diagrammatically the case of a woman, aged fifty, with a uterus the size of a five months' pregnancy. At the curettage the endometrial cavity was nodular. No pedunculated masses were discovered. After 1,800 mg-hr. of radium, bleeding continued at intervals of four to six weeks and lasted from six to ten days. Roentgen treatment (600 r anteriorly and 600 r posteriorly) failed to alter the situation. Hot flashes indicated the presence of the menopause and suggested some mechanical cause for the bleeding. The patient refused another curettage. The uterus became progressively smaller. Two years after the first irradiation there was bleeding of more than the usual amount. She was given 1 cc. of pituitrin, suffered severe cramps and passed several large clots of blood in which was found a spherical mass about 2.5 cm. in diameter. Microscopically this was a myoma with hyaline degeneration. At the curettage the uterus was slightly above the average in size and symmetrical. The endometrial cavity was smooth. No endometrium was ob-

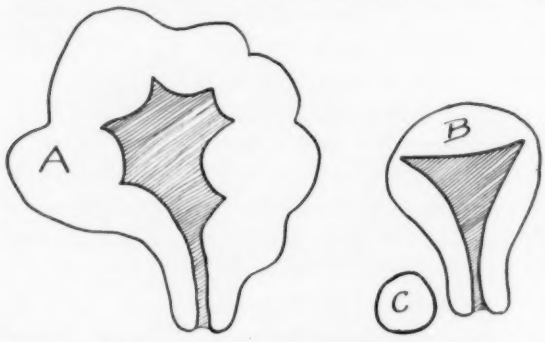

FIG. 2. *A*, uterus of a patient, aged fifty, treated by radium, 1,800 mg-hr. and roentgen rays, 1,200 r. Bleeding continued. Two years later the passage of a myoma *C* from the uterus *B* terminated the bleeding.

tained. There has been no bleeding since (eight years).

Figure 3 is a diagram of the sagittal section of the uterus of a woman of thirty-six who had had elsewhere four curettages and three applications of radium by three surgeons. The pedunculated myoma was flattened from before backward and had the shape of a castanet with a sharp lower edge. A sound or curette entering the uterus on either side of this gave the sensation of being in a normal uterine cavity. The mass was discovered through the use of a polyp forceps. Bleeding ceased after a vaginal myomectomy.

Of the 3 unexplained failures, the first was a girl of eighteen who was given large doses of roentgen radiation by the old Gauss and Krönig technique with practically no effect on the more or less continuous bleeding. The enlarged uterus yielded quantities of hyperplastic endometrium at three curettages. Examination of the uterus after hysterectomy revealed an endometrium nearly 2 cm. thick which showed microscopically a cystic and glandular hyperplasia. The ovaries were grossly normal. There were no hot flashes. In the other 2 cases there were myomata 5 cm. and 10 cm. in diameter respectively. In both hot flashes were induced by combined radium and roentgen treatment but bleeding persisted more or less periodically. Examination of the removed uteri showed a reduction in the size of the tumors; the endometrial cavity was smooth and the endometrium and the ovaries atrophic. Speculation as to the cause of the continued bleeding—aberrant ovarian tissue, ulceration of the endometrium, fibrosis uteri—led to no conclusion.

Dysmenorrhea, whether primary or due to changes in the uterus or to adnexal dis-

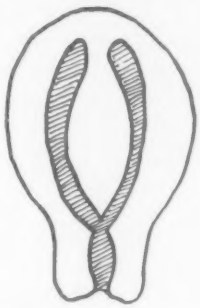

FIG. 3. Sagittal section of a uterus which continued to bleed after four curettages with three applications of radium.

ease, has always ceased when the periods were terminated. The effect of a substerilizing dose was not satisfactory. Of 9 cases so treated, 3 remained free of pain when the periods returned; 2 received further irradiation; 2 had a hysterectomy, and 2 required treatment by other methods. Failure in two-thirds of the cases so treated, together with the objections to the substerilizing dose from the standpoint of genetics, would not encourage the use of this technique.

Pain occurring at times other than during menstruation has usually been the symptom of some complication in the myoma or of coincident disease. Therefore few

TABLE IV

EFFECT OF THE RADIOTHERAPEUTIC MENOPAUSE ON HEADACHE

	Satisfactory			Unsatisfactory		TOTAL
	Immediate Relief	Delayed Relief	Partial Relief	Slight Relief	No Relief	
Periodic, with menstruation	58	13	14	0	1	86
Irregular with exacerbation at menstruation	0	4	2	0	2	8
Irregular	0	2	5	4	11	22
TOTAL	58	19	21	4	14	116

such cases have been treated by irradiation and only when the distress was unimportant. These have not been studied numerically but have been relieved in about 50 per cent of the cases. The same may be said of urinary symptoms which have been relieved in only 40 per cent.

Menstrual molimena of all kinds, nervous, cutaneous, gastrointestinal, etc., require therapy at times. Of these, headache has been most important (Corscaden[1]). Table IV is a summary of the effect of the artificial menopause upon the headache. Only one factor seems to be of importance: the coincidence of the headache with the menstrual period. Where this was definite, relief followed the establishment of the menopause in all but one case. If the headaches occur at other times in the cycle, little can be expected.

Next in importance to the control of symptoms is the effect of irradiation on the size of the uterus. Table V is a summary of the observed results. It is apparent that the effectiveness of irradiation diminishes as the size of the uterus increases, those up to the size of a three to four months' pregnancy being unsatisfactorily reduced in only 4.5 per cent of the cases; those the size of a five to six months' pregnancy in 12.5 per cent, while those reaching above the umbilicus failed to shrink to a clinically insignificant size in 60 per cent. I can offer only one explanation. In the large uteri removed by hysterectomy there has been extensive degeneration, usually hyaline. It is inferred that this degenerated tissue has lost the characteristics of the smooth muscle of the myoma and is therefore not subject to the changes which this tissue undergoes as a result of irradiation and the artificial menopause.

The employment of substerilizing doses for the reduction of the mass has not been satisfactory. Of 15 cases so treated, in only 2 has the tumor continued to shrink while menstruation persisted. Two cases became permanently amenorrheic after small doses of radiation, 600 mg-hr. and 480 r respectively. In 3 cases periods continued scant and irregular while the mass remained unchanged. Hysterectomy was performed in 3 and supplementary roentgen irradiation given to 6. To bring about the shrinkage of a fibroid a complete menopause is, in our experience, necessary, although in the literature cases are reported where periods have persisted while the tumor diminished in size indicating a direct effect on the myoma (Pfahler and Vastine[9]).

Symptoms of pain, fever, leukocytosis and tenderness suggest complications in the myoma and, when present, have contraindicated radiotherapy. Nevertheless among these 730 cases there must have been some uteri which were the site of red or white degeneration. Yet in only 2 cases following radiotherapy has there been pain and tenderness in the mass, leukocytosis and rise of temperature to suggest acute degeneration.

Salpingitis and ovarian tumors are frequently reported in the literature as com-

TABLE V

REDUCTION IN SIZE OF MYOMATOUS UTERI FOLLOWING RADIUM AND ROENTGEN THERAPY

Original Size	Satisfactory Reduction				Unsatisfactory Reduction			Total Cases
	50%	75%	Complete	Totals	None	Slight	Totals	
3–4 mo.	10	27	91	128 (95.5%)	3	3	6 (4.5%)	134
5–6 mo.	5	10	6	21 (87.5%)	0	3	3 (12.5%)	24
7–8 mo.	0	1	1	2 (40.0%)	0	3	3 (60.0%)	5
Total	15 (9.3%)	38 (23.4%)	98 (59.9%)	151 (92.6%)	3 (1.8%)	9 (5.6%)	12 (7.4%)	163

plicating fibromyoma of the uterus in as high as 68 per cent of the cases (Keene and Kimbrough[6]), and it is commonly taught that roentgen and gamma rays will irritate and light up an old imflammatory pelvic process. In the series of cases forming the basis of this study, during twenty-eight years in which irradiation has been employed, there have occurred 4 cases of pelvic infection (Corscaden[2]). All followed the introduction of radium. The inflammatory process was in the endometrium and parametrium. Contamination was probable in 3. All followed a course typical of an infected uterus and should be classed as surgical infections. No case of myoma without diagnosable inflammation treated by roentgen irradiation has had an inflammatory reaction. In fact, in certain cases of pelvic inflammatory disease complicating myoma, radiation in proper dosage has provided an excellent form of therapy. It is apparently a matter of technique. Massive doses may cause an exacerbation of the inflammation whereas small divided doses will accomplish the sterilization with no injurious effect upon the inflammation and possibly some benefit (Desjardins[4]).

Ovarian tumors are difficult to diagnose, especially when small. There is no reliable clinical sign which will differentiate a simple follicular cyst from a cystadenoma and none which will indicate whether a cystadenoma has become a cystadenocarcinoma. While huge doses of radiation affect favorably many cases of carcinoma of the ovary, those of the order given for the treatment of uterine bleeding and myoma uteri are ineffective. And even when effective, irradiation should be used only in conjunction with surgery. Therefore if there is the slightest doubt concerning the presence of an ovarian tumor, the patient should receive the benefit of an exploratory laparotomy. Following this policy we have been fortunate in that only 2 cystadenomata have been discovered, one four years and one five years after irradiation. No other ovarian disease has appeared. Follicular cysts of the ovary apparently disappear after sterilization. One case should, however, be reported because of a partial error in diagnosis. A woman, aged fifty, with a pelvic mass reaching from the cul-de-sac to 4 cm. above the umbilicus, suffered attacks of abdominal pain diagnosed as a twisted right ovarian cyst complicated by a large fibromyoma of the uterus. Because of her general condition (obesity, feeble heart sounds, cholecystitis), it was deemed unwise to operate immediately and the patient was placed on a regimen calculated to make operation safer. In addition it was thought wise to sterilize her in order to shrink the myoma and make the operation technically easier. Accordingly she was given 600 r anteriorly and 600 r posteriorly. Her health improved. The right half of the abdominal mass disappeared completely. The left half was unchanged. The pelvic mass diagnosed as the twisted cyst remained unchanged. Six months after irradiation there were again symptoms of torsion of a cyst. At operation the pelvic organs were easily removed. The right ovarian cyst was twisted through two complete turns. The left abdominal mass proved to be a cystadenoma. It had not changed in the slightest. The myomata which had reached well above the umbilicus on the right side had in six months shrunk so that the uterus was below the average in size. Three small nodules were all that was left of the tumors. The case is reported to emphasize (1) the use of radiation as an auxiliary to operation; (2) the satisfactory reduction of a large myoma, and (3) the complete absence of any effect of irradiation on the cystadenoma.

One case of undiagnosed sarcoma uteri was irradiated and later operated upon. The case, a woman, aged forty-nine, with a history of menorrhagia for two years and metrorrhagia for six months and a uterus the size of a four months' pregnancy, was diagnosed fibromyoma and recommended for dilatation and curettage and hysterectomy. Medical consultants advised against any operation because of hypertensive cardiovascular disease. Therefore a sterilizing

dose of roentgen radiation was given on February 23, 1932. Bleeding continued and the mass increased in size. Hysterectomy on June 3, 1932, revealed sarcomatous change in one of the several myomata. The patient declined rapidly and died on November 4, 1932, with generalized metastases. This case brings up the question of hysterectomy as a prophylactic measure against sarcoma. In our practice we give it little importance. According to our criteria for sarcoma (Corscaden and Stout[3]), no patient with sarcomatous change in a myoma has lived, following any kind of treatment, operative or radiological. Therefore the possible presence of sarcoma in any case should not alter any plan of treatment. Secondly, removal of myomatous uteri for prophylaxis against a condition which has an incidence of 0.025 per cent would destroy, in the clinics reporting the best (1 per cent) mortality about four times as many as it would save (McDonald[7]) and eight times as many in the large charity hospitals throughout the world whose mortality figures for hysterectomy run between 1.5 and 2.7 per cent (Fullerton and Faulkner,[5] Pearse,[8] Read and Bell,[10] Schmitz[11]).

Carcinoma of the corpus uteri was discovered two years after irradiation in 2 cases. Other cases of carcinoma of the corpus have appeared as late as twelve years after treatment and raise the important question as to how far one should go in prophylactic excision of the uterus. Our present problem, however, is that of the diagnosis missed at the time of the curettage. In each of the cases mentioned, the carcinoma was less than a centimeter in diameter and probably was not present at the time of the curettage. Likewise, six years is the earliest at which a carcinoma of the cervix has appeared.

DISCUSSION

The conclusions from this study agree in the main with the conventional teaching concerning the effect of irradiation on bleeding and myoma with the following modifications. Instead of a three months' pregnancy, a five months' pregnancy should be taken as the size beyond which control of bleeding and reduction in the size of the mass becomes less satisfactory. Up to this size bleeding was controlled in 98.1 per cent of the cases and the mass reduced to a clinically insignificant size in 90 per cent. Secondly, submucous myomata were present (as indicated by a nodular uterine cavity at the time of the curettage) in 25 per cent of the cases. There was no appreciable difference in the control of bleeding in these cases except in the 2 uteri in which pedunculated tumors had been overlooked and caused 2 of the 14 failures. The other failures were due to underdosage (5 cases) or failure to allow sufficient time for the destruction of the follicular apparatus of the ovary to be complete (4 cases) leaving 3 (0.4 per cent) in which the therapy was adequate and no condition discovered at operation to explain the failure. Lastly, our experience would bring us in sharp conflict with the almost universal teaching that the presence of pelvic inflammatory disease complicating fibromyoma uteri contraindicates the use of radiotherapy because of the possibility that the irritating action of the electromagnetic waves might light up a latent focus of infection. Following the application of roentgen rays we have had no such experience. Our only infections (4 in number) have followed the introduction of radium into the uterus and were, on the evidence, surgical infections. Furthermore, roentgen therapy has been employed successfully in 10 patients in whom attempted hysterectomy was abandoned because of adhesions, and has been applied effectively to control hemorrhage from large myomata in women recovering from laparotomies performed for gonococcus and streptococcus peritonitis. Apparently it is a matter of technique. It is true that massive doses will cause exacerbation of the inflammatory process but the administration of small repeated doses (50–100 r) will have none but a possibly beneficial effect on the inflammation while they are building up a dose completely destructive to the graafian fol-

licles. Rather than being a hindrance, this effect should be an aid to surgery. The relatively high mortality following operation on this type of case can be substantially reduced.

SUMMARY

In the treatment of 733 cases of uterine bleeding and myoma uteri by radium and roentgen irradiation, bleeding has been controlled in 98.1 per cent of the cases. Of these, 30 (6.1 per cent) of 493 cases treated by radium and 18 (7.6 per cent) of 240 cases treated by roentgen irradiation required supplementary irradiation. The underdosage was deliberate in some cases and in others due to a miscalculation of milligram-hours or roentgens and, with radium, neglect of the law of inverse squares.

In 14 (1.9 per cent) of the 733 cases radiotherapy failed to control bleeding. Of these

- 5 received inadequate doses of radium or roentgen rays.
- 4 were operated upon before sufficient time had elapsed for the irradiation to complete its effect.
- 2 were cases of pedunculated submucous myoma.
- 3 (0.4 per cent) of the total series are unexplained failures.

Dysmenorrhea disappears when menstruation ceases. Following substerilizing doses this symptom reappears in 66 per cent of the patients whose periods return.

Pain other than dysmenorrhea and urinary symptoms have been relieved in less than 50 per cent of the cases.

Uterine tumor is satisfactorily reduced in 94 per cent of the cases if no larger than the size of a five months' pregnancy. When larger than a six months' pregnancy, the tumor has been satisfactorily reduced in only 40 per cent of the cases. Following a substerilizing dose of radiation in only 2 out of 15 fibromyomata was the tumor satisfactorily reduced while the periods still continued.

In 2 cases symptoms and signs of degeneration in the tumor followed roentgen therapy. In no case has roentgen therapy lighted up a pelvic inflammation which, according to statistics, must have complicated some of the myomata. Four cases treated with radium suffered surgical infections following dilatation and curettage and the insertion of radium into the uterus.

One case of sarcoma of the uterus was undiagnosed and treated by roentgen irradiation.

No carcinoma of the uterus has been discovered within two years after radiotherapy for benign bleeding or myoma.

Two cystadenomata of the ovary were discovered four years and five years respectively after irradiation.

CONCLUSIONS

This relatively small number of failures might raise the question, "Why should not most fibroids be treated by this method?" The answer is that these cases are a carefully selected group representing about 30 per cent of the total number of such cases admitted. The others were curable by conservative methods: endocrine therapy for blood dyscrasias, etc., or presented conditions which seemed to the gynecologist to contraindicate radiotherapy; unsuitability of the patient for an artificial menopause, large size of the tumor, a pedunculated submucous myoma, signs of degeneration in the tumor, carcinoma of the uterus, the presence of an ovarian tumor either established or suspected, and the presence of pelvic inflammatory disease severe enough to produce symptoms or pain and urinary symptoms from any cause.

Of these contraindications only the submucous myoma is important as a cause of failure to control bleeding, and carcinoma of the uterus and a neoplasm of the ovary a cause of disaster from neglect. The other conditions are controllable and even if present may not absolutely contraindicate the employment of radiotherapy where the poor general condition of the patient or the presence of massive adhesions or other technical difficulties raise the operative hazard above a reasonable point.

REFERENCES

1. CORSCADEN, J. A. Effect of radiotherapeutic menopause on headache. *Tr. Am. Ass. Obst., Gynec. & Abdominal Surgeons*, 1933, pp. 211–218.
2. CORSCADEN, J. A. Anatomic changes subsequent to radiotherapeutic treatment of benign uterine conditions. *Am. J. Obst. & Gynec.*, 1931, *22*, 74–86.
3. CORSCADEN, J. A., and STOUT, A. P. Sarcoma of the uterus. AM. J. ROENTGENOL. & RAD. THERAPY, 1929, *21*, 155–167.
4. DESJARDINS, A. U. Dosage and method of roentgen therapy for inflammatory conditions. *Radiology*, 1939, *32*, 699–707.
5. FULLERTON, W. D., and FAULKNER, R. L. Hysterectomy; clinical investigation of 1,851 consecutive operations. *J. Am. M. Ass.*, 1930, *95*, 1563–1567.
6. KEENE, F. E., and KIMBROUGH, R. A., JR. Fibromyoma uteri, treatment and end-results; review of 254 cases. *Am. J. Obst. & Gynec.*, 1930, *20*, 198–208.
7. MCDONALD, E. P. Panhysterectomy; study based on 2,773 consecutive hysterectomies. *New York State J. Med.*, 1939, *39*, 503–508.
8. PEARSE, R. L. Supravaginal hysterectomy; statistical survey of 1,900 cases, with especial reference to later development of carcinoma in retained cervix. *Surg., Gynec. & Obst.*, 1934, *58*, 845–851.
9. PFAHLER, G. E., and VASTINE, J. H. Irradiation in treatment of fibromyoma of the uterus. AM. J. ROENTGENOL. & RAD. THERAPY, 1934, *31*, 51–59.
10. READ, C. D., and BELL, A. C. Hysterectomy, subtotal and total—review of mortality and morbidity of subtotal and total operations on series of 2,344 consecutive cases at Chelsea Hospital for Women in the ten-year period 1922–1931 inclusive. *J. Obst. & Gynaec. Brit. Emp.*, 1933, *40*, 749–767.
11. SCHMITZ, H. E. Mortality and complications of 3,129 supracervical hysteromyomectomies. *Am. J. Obst. & Gynec.*, 1937, *34*, 480–485.

DISCUSSION OF PAPERS BY DRS. NEWCOMER AND CORSCADEN

DR. LEDA J. STACY, White Plains, N. Y. I enjoyed both of these papers very much. I was especially interested in Dr. Corscaden's discussion of the failures in radiotherapy for uterine bleeding, for I have followed the work in his tumor clinic for the last four years and have been much impressed by the faithfulness with which the follow-up work is carried on and the cooperation of the patients. I believe that every patient treated returns at least once a year for examination for as long as she lives.

In his paper Dr. Corscaden mentions the rarity of pelvic infection following the intrauterine insertion of radium. In reviewing a large series of cases of menorrhagia treated with radium which I reported a few years ago, there were noted several cases of apparent lighting up of a quiescent pelvic cellulitis which led me to consider a previous history of pelvic infection a contraindication for the use of radium. Evidently the trauma incident to the insertion of radium was a large factor in these instances rather than the action of the radium, for in Dr. Corscaden's clinic a number of patients have been treated for subacute pelvic infection by roentgen irradiation with satisfactory results. My experience has been similar to that of Dr. Corscaden in that the chief cause of failure to obtain satisfactory results in the control of benign uterine bleeding by radium has been the presence of submucous fibroids. The presence of submucous fibroids can usually be detected during the curettement preceding the insertion of radium into the uterine cavity.

Dr. Newcomer's presentation was interesting As my associations have been with a surgical clinic, all patients with carcinoma of the body of the uterus have been operated upon, a total abdominal hysterectomy of the modified Wertheim type being done, except of course when the lesion was extensive, or the patient a poor surgical risk. Some ten years ago, I reported the results in a series of 288 traced cases thus treated at the Mayo Clinic. There was a five year cure in 63.88 per cent, and of the 172 traced, who had been operated upon ten years or more previously, 44.18 per cent were living for ten years.

As one reviews the statistics published by the various large clinics, there is not a great difference in the results obtained in this group, whether treated by roentgen rays and radium, or by roentgen rays and hysterectomy. Dr. Healy has reported good results as does Dr. Newcomer with radium and roentgen rays. As Dr. Newcomer has pointed out, one does not so often see local recurrences in cases of cancer of the body of the uterus, but distant metastases to bone and lungs.

Because of my previous experience, I still feel that total abdominal hysterectomy with dissection of the regional lymph nodes, done by a competent surgeon, is the treatment of choice

in those patients in whom the uterus is still movable.

DR. HERBERT E. SCHMITZ, Chicago. I would like to emphasize the one point that radiation therapy is not a substitute for surgery. There are definite indications for radiation treatment of benign menopausal bleedings and bleedings due to fibromyomata. If we have an intramural or subserous myoma the size of a first trimester pregnancy or smaller, in a patient over forty years of age, the treatment is radiation therapy. If we have benign uterine bleeding at the time of the menopause, irradiation is not a substitution but the ideal treatment. That is the one thing that we must emphasize. Too many surgeons and general practitioners believe that we are trying to offer a substitute when, in fact, we have the method of choice.

DR CORSCADEN (closing). Whether or not roentgen treatment of pelvic inflammatory disease complicating fibromyoma causes an exacerbation of the inflammation is determined by the daily dose. Most of the reports of the lighting up of these latent infections are from the days when massive doses were given. In our experience if a daily dose of 50 roentgens is given, no exacerbation will occur.

If I may cite a case, a woman was admitted with diffuse peritonitis which at operation was found to come from a ruptured pyosalpinx from which a pure culture of gonococcus was obtained. There was a fibroid the size of a six months' pregnancy. The abdomen was drained. Thirteen days following operation, uterine hemorrhage occurred. She was given several transfusions and radiotherapy begun. Fifty roentgens a day for three days produced no change in the temperature. Following a dose of 150 roentgens, the temperature rose to 102° F. Irradiation with 50 roentgens a day was continued until 600 r had been given anteriorly and 600 r posteriorly without further rise of temperature.

THE PROGRESS OF RADIUM SINCE ITS EARLIEST THERAPEUTIC AVAILABILITY*

By ALBERT SOILAND, M.D., D.M.R.E.
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LOS ANGELES, CALIFORNIA

AT THE organization meeting of the Los Angeles Clinical and Pathological Society in 1903, I was afforded opportunity to exhibit to those present a spinthariscope obtained in London. This occasioned considerable wonderment and discussion. Later the first therapeutic radium came to my office in the shape of a little "button," containing approximately 5 milligrams of radium salt. In 1905, in Paris, I purchased a 10 milligram plaque and, strange to relate, these two early and infinitesimal fragments of radium clearly demonstrated their potency in the treatment of certain superficial skin lesions of a malignant nature. By 1910, radium had been definitely established and accepted as a new arm of precision in the treatment of selected cases of circumscribed cancers of skin and mucous membrane origin. If time and space permitted, there could be related many incidences of skepticism, antagonism, and ridicule from our brother practitioners during the long and probationary years before radium therapy reached the almost universal acclaim it now enjoys. Radiologists, with the splendid assistance obtained from physicists, have now harnessed the energy from radium and through various and skillfully assembled plaques, tubes, cells, needles, and packs have applied its potential powers to practically every accessible part of the body subject to neoplastic disease.

Many excellent papers on radium therapy have appeared in the last decade and one is hesitant as to what particular phase of the subject might prove most illustrative and interesting. Elemental radium in its varied and accurately measured containers has been thoroughly described, tested by time, and correctly tabulated. Gaseous radium, or emanation, meticulously injected into tiny glass, gold, or platinum tubules, has found its rightful place in tumor tissue beyond the ready reach of topical or external irradiation. The technique and practical application of radium during the past two decades are now matters of record so that at this time I have only to point to the rich harvest of clinical results in neoplastic disease written in a universal language from every part of the world.

Therefore an attempt will be made to discuss briefly the present status of the radium pack or bomb containing 1 gram or more of radium element. Radium bombs, or packs, ranging in content from 1 to 10 grams, have now been in active clinical use for nearly fifteen years, but there is still no unanimity of opinion among radiologists as to the value of mass radium gamma emissions compared with those obtained from supervoltage roentgen rays. Among the first to embrace the radium bomb was Regaud of Paris, who, in the early days of his experience, became enthusiastic about its possibilities. In fact, he told me that he no longer considered carcinoma of the rectum a hopeless condition and felt that it would probably be mastered by his 4 gram radium pack. Later he, like many others, modified his opinion considerably, having learned as time went by that many of his earlier successes were not lasting. By comparison, in 1930, we treated for the first time a case of inoperable carcinoma of the rectum with supervoltage roentgen therapy (750 kv.), and this patient lived free from pain and bleeding for over three years, only to die from an intercurrent pneumonia. We have had considerable success in treating carcinoma of the rectum since then, but no one case was so striking as this first experiment.

At the moment of writing, one of our as-

* Read at the Twenty-fifth Annual Meeting, American Radium Society, New York, N. Y., June 10–11, 1940.

sociates gave me the following news item clipped from the Saturday *Evening Post* of March 9, 1940.

London: "I think the world would be little worse off if all the radium now buried for security against bombing remained there," Sir Leonard Hill, noted Physiologist, declares. Sir Leonard said that evidence shows that radium in an intensity to produce an effect on the human body is harmful, and that modern X-ray methods can do all that radium does physiologically.

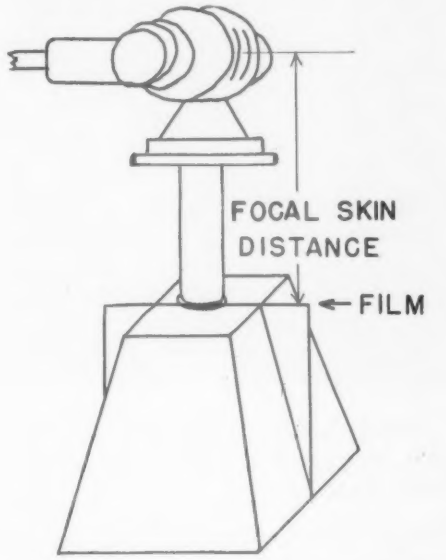
This is one more example where thoughtless remarks, based upon ignorance or prejudice, convey to the interested public not only a wrong but a malicious and misleading statement. That any intelligent person can, in the face of incontrovertible evidence to the contrary, so disparage the efficacy of radium is inconceivable.

An illuminating report on Radium Therapy for Cancer has recently been published by Paterson[2] of Manchester, England, and I am taking the liberty of quoting his opening paragraph with which I heartily agree.

It is, I think safe to say that at the present time there are still only three methods by which malignant disease, once established, can be successfully treated, namely: surgical excision, radium treatment and x-ray therapy. Of these it must be appreciated that the last two (radium and x-ray) are fundamentally the same weapon and should not be looked upon as two distinct methods but as one—Radiotherapy. It is, to my mind, essential that control of both agents be in the same hands if the best results are to be obtained.

It may be of interest now to compare the radium bomb with artificially produced gamma rays by means of short wave roentgen rays of over 600 kv. Our own experience with a 4 gram bomb is scarcely one year old. The time is too short, therefore, to draw definite conclusions. We have, however, followed the technique and observations of those who speak with authority, based upon a long and rich experience, and hope our endeavors may meet with success.

On the other hand, we are on safe ground in evaluating from personal experience over a ten year period what can be expected from 600 kv. roentgen-ray emission. That we have secured results superior to any we have previously observed with lower voltages is an obvious fact. Some rather striking photographs of so-called radioresistant neoplasms successfully treated have been exhibited before various medical groups and those who have seen them will prob-



FOCAL SKIN DISTANCES

100 K.V.	30 CM.
200 K.V.	50 CM.
600 K.V.	50 CM.
RADIUM PACK	6 CM.

FIG. 1. Diagram of procedure with factors involved. Note lead box is cut into vertical halves between which light proof enveloped film is tightly compressed.

ably agree that we are justified in going ahead. It may be possible from this angle to demonstrate within a reasonably short time that the radium bomb and the very short wave roentgen-ray beam will add materially to the already brilliant results achieved in the past with the energy of radiation before the present gamma-ray giants were made available. During the past few years, together with my clinical associates, I have presented several papers[1,4,5] dealing with our experience in the higher voltage field.

Fig. 2. Radium, 100 mg.; film distance, 6 mm.; filter equivalents, 2 mm. gold, 2 mm. rubber, 2 mm. paper; dose, 5 r.

We have been careful and conservative in our claims and have refrained from attempting to create statistical reports although they may now be in order. In fact, at the meeting of the Northern Society for Medical Radiology last summer in Oslo, Norway, when I presented that subject, one of the delegates present said something to the effect that he had heard about supervoltage for ten years and what he now desired was statistics. It appears necessary, therefore, to begin a statistical survey in the immediate future.

On a recent visit with Dr. Ernest O. Lawrence, our latest winner of the Nobel Prize in Physics, at the University of California in Berkeley he demonstrated a simple and practical manner by which the penetration of neutron particles could be visualized on a film. Acting upon this demonstration, I have made a few photographic experiments comparing the penetration of radium and roentgen rays (Figs. 1–6).

Whether these experiments can serve as definite physical measurements of depth dosage is doubtful. Nevertheless, I am convinced that the films show something of value, so far at least as pertains to penetration, ionization, and a relative demonstration of the photo-electric and the Compton effects. The films are placed in light proof envelopes, one edge of which is adjusted in application to the central exit of the radiation beam. In open air and without opaque medium surrounding the films, no sharp lines of demarcation can be expected, due of course, to halation and backscattering. Therefore, such photographs show more or less blackening of the entire film with the densest shadows naturally amplified near the entrance of the beam. When, however, paraffin or wood plastics are employed to surround the film, thus simulating treatment conditions of the human body, the deeper shadows on the films are seen to follow more or less the central radiation beam throughout the depth of the film, provided, of course, that the source of radiation is walled off and limited strictly to the area under exposure. Further, if a lead funnel

Fig. 3. Radium, 4,000 mg.; film distance, 5 mm.; filter equivalent, 3 mm. platinum; dose, 5 r.

with aluminum protection to eliminate backscattering is placed around the opaque medium, so arranged as to follow the natural direction of the radiation beam, a more satisfactory image is obtained. Whether or not this investigation has any intrinsic merit, I am not sure, but it does, I believe, substantiate our clinical knowledge of depth dosage and points out what has before been observed, i.e. short wave roentgen therapy in attacking lower levels of the body has certain advantages over teleradium which, it appears, is verified by the photographic films herewith presented.

Were it possible to secure a radium head, containing 20 to 25 grams of radium, it would appreciably enhance the scope of telecurie radiation therapy.[3] While the cost of such installation seems at the present prohibitive, not only the cost of the radium itself, but also the material and physical protection and safety factors for operation, nevertheless one of the larger endowed institutions might find it possible of accomplishment and it would be a worthy undertaking. With this amount of radium available, one might venture the opinion that, after the first cost of installation had been taken care of, the operation would be on a rather minimal cost basis and would prove economically sound. The possibility of several treatment portals and more effective depth dosage is also an important factor.

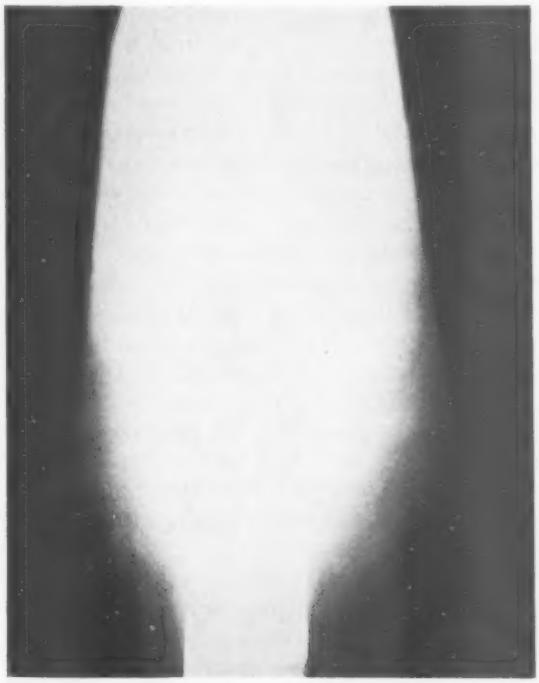


FIG. 4. Roentgen rays, 100 kv.; film distance, 30 cm.; filter equivalents, 0.25 mm. copper, 1.0 mm. aluminum; dose, 5 r.

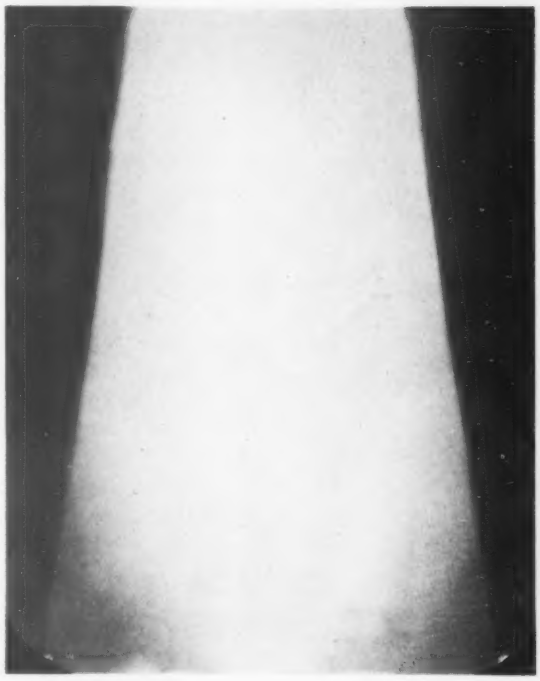


FIG. 5. Roentgen rays, 200 kv.; film distance, 50 cm.; filter equivalents, 0.5 mm. copper, 2.0 mm. aluminum; dose, 5 r.

CONCLUSION

As has been stated by many authorities, one must realize that radiation therapy is young and amenable to a vast amount of research, development and improvement. We cannot forecast what lies in store for the next generation. With a steadily growing rank of young and earnest radiological students, we may expect that our present day achievements in the fight against cancer will be far exceeded by future radiologists.

That which has gone before is indelibly inscribed in the archives of history. Ultrashort wave radiation from radium and roentgen rays has unquestionably added to

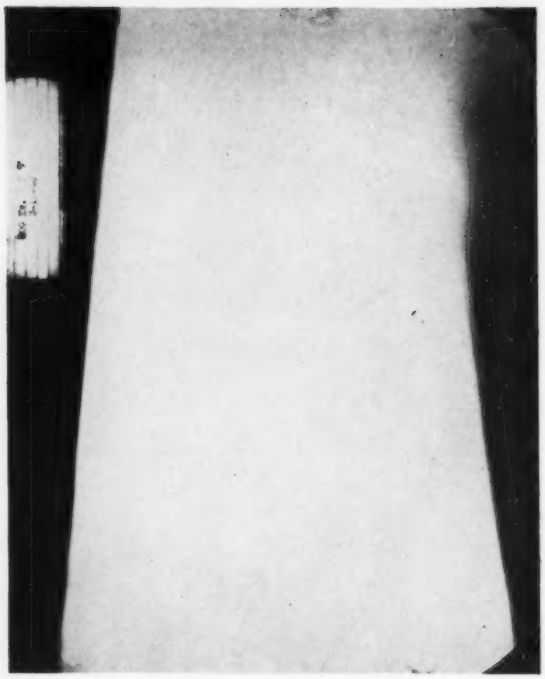


FIG. 6. Roentgen rays, 600 kv.; film distance, 50 cm.; filter equivalent, 1.0 mm. lead; dose, 5 r.

our clinical attainments; and the startling investigations and research on neutron discharges by Ernest Lawrence bid fair to place in our hands a new and perhaps revolutionary agent of radiation with which to attack mankind's deadliest enemy.

REFERENCES

1. COSTOLOW, W. E. Supervoltage roentgen rays in treatment of deep seated malignancies. *West. J. Surg.*, 1937, *45*, 255–259.
2. PATERSON, R. Cancer from the point of view of radiotherapist. *Brit. J. Radiol.*, 1939, *12*, 526–531.
3. SOILAND, A. A few remarks on radium therapy. *Radiol. Rev. & Mississippi Valley M. J.*, 1936, *58*, 47.
4. SOILAND, A. Further studies of action of supervoltage radiation in malignant disease. *Urol. & Cutan. Rev.*, 1938, *42*, 299–301.
5. SOILAND, A. Clinical observations in use of supervoltage roentgen rays based upon six years' experience. AM. J. ROENTGENOL. & RAD. THERAPY, 1938, *40*, 52–62.

ADDENDUM

Although space does not permit the inclusion of a really comprehensive review of the literature, a few excerpts with reference to the opinions and experiences of others working with teleradium and ultrashort wave roentgen rays are herewith included.

(1) From 1921 to 1933, Berven[1] treated 20 cases of anorectal cancer usually with the combined roentgen and teleradium treatment with implantation of radium needles in and around the tumor. In a number of instances electrocoagulation was used and in one case the rectum was amputated. Of the 20 cases, 17 have been followed for five years or more. (Seven, or 35 per cent, were symptom-free for three years or or more.) After a five year period, 4 were symptom-free; 1 of these has since died of cancer of the transverse colon and 2 have developed pulmonary metastases (in 1 case after seven years of freedom from symptoms), and the fourth, a case of inoperable, papillomatous cancer with inoperable metastases in both inguinal regions was treated entirely with moderate doses of teleradium and is still alive and without symptoms five years later.

(2) Lacassagne[6] concludes that the efficacy of local radium therapy alone is proved by the fact that a cure can be obtained by this method in 74 per cent of the cases of cervico-uterine cancer in the first degree. On the other hand, this technique is frequently not sufficient in Group II cases and almost completely ineffectual in Group III cases. The study of recurrences justifies the hope that a greater proportion of cures in Group I will be obtained by treating these cases systematically with a combination of intracavity and transpelvic irradiation.

(3) Edling[2] feels from his experience that teleradium treatment on the whole is encouraging. He discusses methods, results and the difficulties encountered. By comparison, he feels that teleradium treatment in cancer of the larynx and hypopharynx is superior to other methods of radium therapy, is less trying than the Coutard method, and is less mutilating than surgery, especially of the nasopharynx. He has never observed any untoward heart conditions in teleradium therapy.

(4) Maier[10] reports some of the results obtained in the treatment of cancer with teleradium. Since 1931, there were 1,024 patients seen, 840 of these were treated with the 5 gram bomb. There were 120 cases of carcinoma of the tongue; 66 could be observed for a period of three years; 20 of these patients are symptom-free. He believes that teleradium therapy is not

to be considered as competitive to roentgen therapy but it has its own field of usefulness and should be applied according to definite established indications.

(5) In discussing the treatment of the lymph node metastases from carcinoma of the lips and of the oral cavity, Engelstad[4] presents material from the Norwegian Radium Hospital. The results for a period of from two and a half to six years are as follows:

Oral carcinoma (135 patients)—32.6 per cent symptom-free; of the patients without metastases 61.1 per cent; and of the patients with lymph node metastases 17.4 per cent. The corresponding figures for the lip carcinomas (141 cases) are: 66.2 per cent, 87.7 per cent and 48.2 per cent. The treatment of the lymph node metastases has been varying, but the best results are obtained with teleradium treatment, if necessary combined with a total bloc dissection. After this treatment, local recurrences are very rare. It is advised to make a more extended use of prophylactic irradiation of the glandular regions in the treatment of oral carcinoma.

(6) Heyman[5] sums up as far as gynecological carcinoma is concerned with the statement that the addition of teleradium therapy to our other means of treatment has given noticeable results, both primary and lasting, in cases with extensive involvement of the parametria; in cases with isolated glandular metastases; and, above all, in cases of carcinoma spreading chiefly downward along the vagina; and that the primary results, with a consequent palliation, have been decidedly better than those obtained by previous methods.

(7) Engelstad,[3] in presenting a statistical review of his experience with telecurietherapy feels encouraged even though the number of cases reported is small and the time element relatively short. He feels that telecurietherapy is chiefly indicated in cancer of the buccal cavity and is perhaps the most important indication of all.

(8) In the summary of his research work on artificial radioactivity and neutron rays in biology and medicine, Lawrence[7] states that "Modern developments in physics led to the induction of radioactivity in nearly all the elements and the production of a new form of biologically active and penetrating radiation—the neutron ray. Radioactive elements are 'tagged' atoms but chemically they resemble their inactive relatives. Hence study of their distribution after injection, by means of an electroscope or a Geiger counter, gives fundamental information concerning the metabolism of the various elements. Furthermore, a new method of comparing normal and disease processes is made possible. The selective deposition of elements in tissue (phosphorus in bone, iodine in the thyroid) introduces a new method of selective radiation and offers possibilities in therapy. The advent of these new tools in medical research is an outgrowth of pure science and necessitates the cooperation of the physician with the physicist, who has opened up this fascinating field of investigation."

(9) Following their research work on neoplasms with the aid of radioactive phosphorus, Lawrence, *et al.* [8,9,11] came to the following conclusions: "Unlike x-rays, which penetrate great distances in tissue, the beta-rays from radiophosphorus penetrate less than a centimeter and thus act locally. Therefore, the relatively high concentration of radio-phosphorus in leukemic tissues gives us a method of somewhat localizing the irradiation to the infiltrated areas, and this should prove valuable in the therapy of this disease."

In their further studies on leukemia, the authors made observations on 6 leukemic patients, 1 lymphatic, 1 myocytic, and 4 myelogenous.

The major portion of the dose (by mouth) of phosphorus (as sodium phosphate) was absorbed during the first three days and thereafter excreted in small amounts in the urine and feces, chiefly in the former.

Larger doses decreased the white blood cells in a manner similar to that following roentgen irradiation. Greater deposition of phosphorus in bone marrow and bone than in other human tissues and its probable relatively large deposition in leukemic tissues (as shown in experiments on leukemic mice) suggests that this offers a method of giving selective irradiation in leukemia. The authors feel that since there is no completely satisfactory treatment of this disease it seems justifiable to use this method cautiously in therapeutic attempts, in addition to its use as a tracer of the metabolism of phosphorus in this disease.*

REFERENCES

1. Berven, E. Radiological treatment of cancer of rectum. *Acta radiol.*, 1939, *20*, 373–390.
2. Edling, L. Primary results of teleradium treatment in cancer of larynx and hypopharynx at

* For discussion see page 690.

Radiologic Clinic of University of Lund, 1931–1933. *Radiology*, 1935, *25*, 267–273.

3. Engelstad, R. B. Télécuriethérapie des tumeurs malignes. *Acta radiol.*, 1936, *17*, 421–438.
4. Engelstad, R. B. Treatment of lymph node metastases from carcinomas of lips and oral cavity. *Acta radiol.*, 1938, *19*, 546–553.
5. Heyman, J. Tele-radium-treatment in uterine cancer. *Acta radiol.*, 1937, *18*, 501–503.
6. Lacassagne, A. Limitations of intracavitary radium therapy in cancers of cervix of uterus. *Radiology*, 1939, *33*, 20–24.
7. Lawrence, J. H. In: Handbook of Physical Therapy. American Medical Association, Chicago, 1939.
8. Lawrence, J. H., Scott, K. G., and Tuttle, L. W. Studies on leukemia with aid of radioactive phosphorus. *Internat. Clin.*, 1939, *3*, 33–58.
9. Lawrence, J. H., Tuttle, L. W., Scott, K. G., and Connor, C. L. Studies on neoplasms with aid of radioactive phosphorus; total phosphorus metabolism of normal and leukemic mice. *J. Clin. Investigation*, 1940, *19*, 267–271.
10. Maier, E. Die Radiumdistanzbehandlung. *Strahlentherapie*, 1937, *58*, 593–598.
11. Tuttle, L. W., Scott, K. G., and Lawrence, J. H. Phosphorus metabolism in leukemic blood. *Proc. Soc. Exper. Biol. & Med.*, 1939, *41*, 20–25.

RADIUM BEAM THERAPY*

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SINCE 1930 Bellevue Hospital has had 5 grams of radium, and we believed this amount could best be employed in the form of a single pack to provide a relatively intense source of gamma radiation. Besides, there are many patients who could not be transported to the Radiation Therapy Department for treatment with high voltage roentgen rays but who could be moved in bed to a lead-lined radium room for radium pack treatment. To be able to apply this radium pack to patients in bed, it was necessary to devise and construct a special type of stand and radium holder which could be adjusted over the bed in various positions.

The original 5 gram pack we constructed in 1930 was described the following year.[1] After using it for several months it was found desirable to increase the protection against stray radiation from the pack and this was accomplished to some extent by providing the pack with a lead shutter arrangement. Even with this improvement, however, it became necessary to take further precautions to lessen the stray radiation received by the operators and yet not sacrifice any of the flexibility of the pack. With this in mind, our physicist, C. B. Braestrup, designed a new pack with a remote control arrangement of the radium. In this latest design all the radium tubes are mounted on a flexible metal conveyor chain, which permits the radium to be moved behind a 3 cm. lead block when not in use. This chain is operated by an electric motor controlled from the operator's position by a push button system. This arrange-

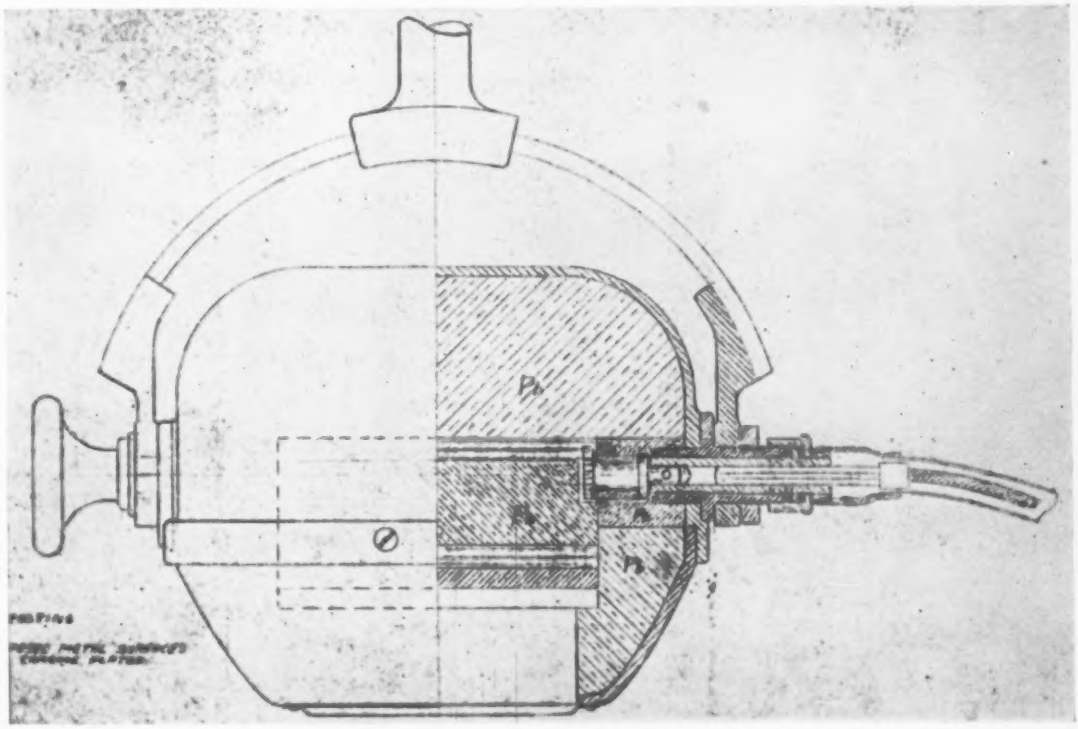
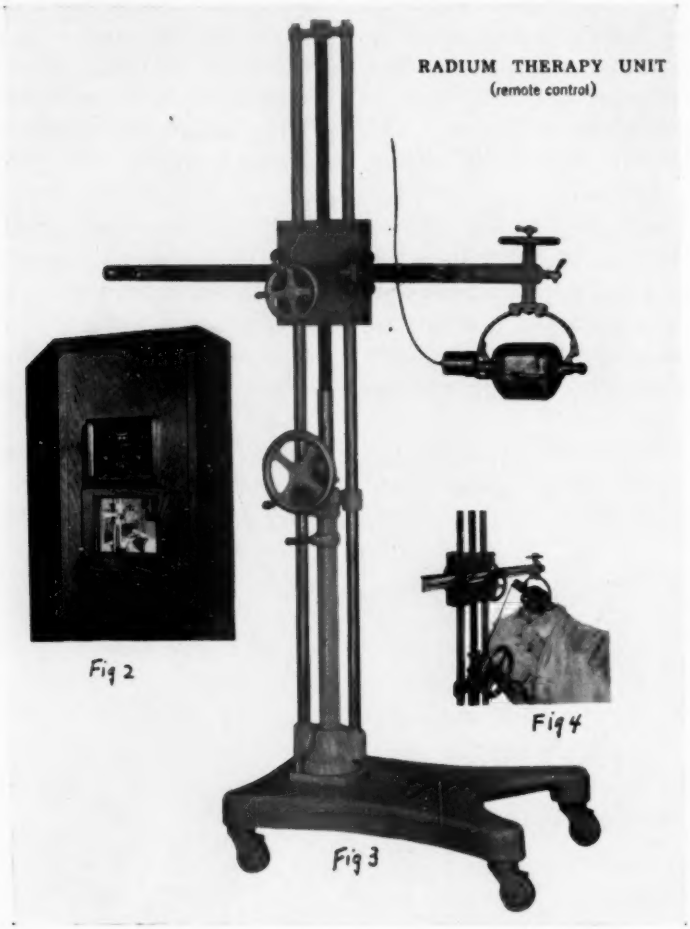


FIG. 1

* Read at the Twenty-Fifth Annual Meeting, American Radium Society, New York, N. Y., June 10–11, 1940.

ment is illustrated in Figure 1. An important point that had to be borne in mind when the use of the radium pack was being considered was its effect on the physicians and nurses who would be required to manipulate it. The intensity of the stray radiation was tested in order to ascertain whether or not it would reach the personnel working in the radium pack room. It was finally arranged to have the pack within a specially constructed, lead-lined room, with the nurse observing the patient through a lead glass window and working the mechanical apparatus to place the radium in function behind the lead barrier. By this arrangement the personnel is less exposed to the radium rays during the time that the pack is set in treatment position on the patient (Fig. 2). Only after the technician and physician are outside the treatment cubicle and behind the protective lead barrier is the radium moved into position opposite the treatment area, being kept behind the lead block until automatically moved into the operating position by the control apparatus.



Figs. 2, 3 and 4

After the patient has been prepared and the holder positioned for treatment, the remote control device operated from a panel outside the pack room, actuates an electric motor moving the conveyor chain so that the links containing the radium tubes are carried to the exposure portal. When the treatment is concluded, the operation is re-

versed and the radium tubes returned to their labyrinth, whereupon the radium holder can be safely handled. The accompanying diagrams show the method employed. Neon lights on the panel indicate whether the chain is in the "off" or "treatment" position. For operation the appropriate push button is depressed until both lights signal, then the circuit automatically opens, when the chain has reached its proper position.

This arrangement includes an electric timer so that after the predetermined length of time, the radium is automatically brought back into a position of safety. This prevents excessive exposure to the patient in the event of any oversight by the operator.

Various other special features are incorporated in the 5 gram radium treatment pack in use at Bellevue Hospital. Mounted on a mobile stand, it may be moved about readily although, naturally, it is extremely heavy (Fig. 3). The mechanism for raising and lowering includes a geared jack screw and can be handled with a minimum of effort and time. Positioning the pack is particularly easy, because of the geared cross arm and the swiveled upright structure, all of these parts being mounted on precision type ball and roller bearings. Angulation of the pack is effected in three mutually perpendicular planes and may be quickly and easily done by the use of extension rods to enable the operator to avoid excessive exposure. When located, the bomb can be clamped firmly* into position (Fig. 4). Of particular interest is the arrangement of the radium tubes. Another advantage of this arrangement is the greater depth dose obtained by having the tubes form an arc with a radius of 11 cm. with the center tube located 5 cm. below the skin. This is the average depth of the lesions treated with the pack.

Inasmuch as the radium is distributed in one hundred tubes it was not possible to have just one layer. The tubes are therefore arranged in two layers but in such a way that the lower tubes do not shadow the upper tubes at the depth of 4–8 cm. At the surface, however, the rays from the upper tubes are reduced in intensity by partially passing through the lower tubes. The result of this grid effect is a higher depth dose. It should be emphasized that in the design of this pack we were, for economic reasons, limited to the simplest possible construction. We hope to add additional automatic features to reduce the handling of the pack to a minimum.

Clinical dosage with the 5 gram pack was devised on an empirical basis. With the previous pack described above it was ascertained that a daily dose of 5,000 mg-hr. (8×10 cm. portal; 6 cm. radium-skin distance) would produce skin and mucosal reactions equivalent to a daily dose of 400 r of roentgen rays produced by 200 kv., 0.5 mm. Cu plus 1 mm. Al filter, with backscattering. With the newest pack herein described, similar reactions are produced by 5,750 mg-hr. The increased number of milligram-hours is made necessary by the arc-like distribution of the radium source.

In comparing the 5 gram pack with high voltage roentgen rays by administering protracted fractionated radiation to tumors of the upper respiratory tract, it was found that with the daily doses above mentioned a total dose of 60,000 mg-hr. administered to each of two lateral neck portals would produce reactions of epithelitis and epidermitis similar to those produced by a total dose of 2×4,000 r (measured with backscattering) over a period of approximately twenty-eight days. In terms of skin erythema doses, these figures represent 3.5 S.E.D. for the radium gamma rays and 4.5 S.E.D. for the roentgen rays. Thus gamma rays of radium will produce certain biologic effects with a smaller number of skin erythema doses than is required of roentgen rays. This is the one feature in the comparison of the two types of rays that has not as yet been explained on a purely physical basis.

When gamma rays of radium are used in

* The pack was constructed for us in accordance with our plans by the Peerless Laboratories, New York.

fractionated irradiation of tumors of the upper respiratory tract in doses that produce equivalent skin reactions to those of roentgen rays it is observed that the radium gamma-ray epithelitis reactions are less intense than the roentgen-ray epithelitis reactions. This may be explained in part by the reduced depth dose. However, it is our impression that even though the epithelitis is of lesser intensity, the effect on the tumor of the tonsil or larynx, etc., is at least as good as that produced with roentgen irradiation. Although this is a striking observation, it nevertheless is true in our experience to date.

In comparing roentgen and radium gamma rays by means of erythema dose tests, it has been observed that the radium gamma-ray erythema appears at a much later date and lasts longer than does the roentgen-ray erythema. When these two types of radiation were administered in daily fractionated doses to the neck so as to produce severe second and third degree reactions, these reactions occurred at approximately the same time. This is due to the fact that radiation in large doses produces severe destructive effects and these tend to be constant in time of onset and severity so as to obliterate any delicate ray quality differentiation effects.

At the outset in undertaking this work we realized the importance of close cooperation between the clinician and the physicist, and grateful acknowledgment is made to the Physics Department for assistance in the designing, construction, measurements, standardization, dosage and protection methods provided in this pack.

It will be noted that in the operating position the radium tubes are located on an arc, the center of which lies approximately 5 cm. below the surface of the patient treated. With this arrangement the depth dose is improved considerably. Measurements made on the patient show that the percentage depth dose in the vagina at a point 8 cm. below the skin is 22 per cent. This compares with 38 per cent obtained with 200 kv., 0.5 mm. copper, 1 mm. aluminum, 10×15 cm. field, 50 cm. distance. Various sizes of cones are used to localize the areas to be treated and the distance to be employed. In our first pack the filtration was 0.5 mm. platinum plus 5 mm. lead. In the present pack the filtration is equivalent to 2.0 mm. platinum. The radium tubes have a wall filtration of 0.5 mm. platinum. The additional filtration is provided by lead 1.7 mm. thick and 3.2 mm. brass.

In the report published in 1935,[2] the action of the radium pack was compared with that of roentgen therapy in the treatment of cancer of the larynx. It was our conclusion then that there appeared to be but little appreciable difference between roentgen rays and gamma rays so far as the primary effect upon the tumor was concerned. Since then we have treated with the radium pack metastatic carcinomatous lymph nodes which had become refractory to roentgen rays, and in a number of instances, these nodes have responded well.

The problem of interstitial irradiation is important, for it is our general impression that protracted external irradiation alone does not entirely eradicate all of the more common radioresistant carcinomas; in advanced cases it rarely destroys this type of carcinoma. Local surface healing of the lesion may at times occur with residual cancer cells locked up in fibrous tissue which may later become reactivated. It is for this condition that interstitial irradiation is needed.

In planning treatment with the pack, our aim is to deliver as adequate and homogeneous irradiation as possible to all of the involved tissues. Doses are given large enough to destroy the entire tumor so that no residual cells can regrow, and yet not an excess dose that might cause radionecrosis of normal tissues. Although by experience we have learned that very large doses of gamma rays from this pack can safely be administered, in some unfortunate instances necrosis did occur. This was especially noticeable when the primary lesion was associated with infection.

Treatment is directed through the pri-

mary lesion alone, the metastatic lymph node areas alone or through an area containing both.

The successful treatment of any cancer depends to a great extent upon the control of metastatic lymph nodes. After observing the results of treatment with the 5 gram radium pack over a number of years, we are of the opinion that the gamma rays of this pack have an appreciable selective action, particularly for metastatic lymph nodes, which action is not evident with roentgen therapy.

In localized lesions complete regression of the lesion followed radium pack treatment. In some cases where treatment for the primary growth was directed through areas in which secondary lymph node involvement existed, regression of the metastatic nodes followed control of the primary lesion. In advanced lesions definite regression was noted in many instances, even in cases of recurrence after previous roentgen irradiation which had for a time reduced the original growth. Where secondary metastasis had occurred radium pack treatment in some cases definitely made such lesions regress and at times even completely disappear. In some cases radium pack treatment produces results heretofore achieved only by radical mutilating surgery.

In a previous report[3] I described in detail the histological changes we had observed on cancer tissue in the treatment of cancer of the cervix by radium pack. Subsequent studies have confirmed these findings.

In treating brain tumors we have found that patients tolerate very large doses of radium pack therapy without any deleterious effects. The radium pack treatment offers the advantage of effective intensive gamma-ray irradiation through multiple skull portals with but little discomfort to the patient. In our opinion this method is far more advantageous than interstitial irradiation with gold seeds.

During the past five years we have treated 447 cases with the new 5 gram pack. The types of cases were:

Breast	107
Larynx	22
Thyroid	14
Lung	8
Cervix	17
Miscellaneous	97
Mouth	49
Hypopharynx-Pharynx	22
Parotid	19
Esophagus-Stomach	11
Sarcomas	83

In several cases of inoperable breast carcinoma, crossfire therapy with the radium pack definitely reduced the size of the primary growth, caused regression of the metastatic lymph nodes and prolonged life with some degree of comfort.

The results obtained in many cases warrant the continuance of this form of therapy and substantiate our conviction that it is of definite value in the treatment of cancer conditions which otherwise are not amenable to irradiation. The following cases illustrate the method of treatment.

REPORT OF CASES

CASE I. E. D., female, aged thirty-nine, single, admitted February 14, 1934.

Complaint. Mass in right breast.

Diagnosis. Inflammatory cancer of the breast, surgery contraindicated.

Pathology. Duct cell carcinoma.

Treatment. Five gram pack, 6 cm. distance, 3 portals, inner anterior and axillary, 45,000, 35,000, 40,000 mg-hr. respectively. Treatment given one hour per session at daily intervals to alternate areas. July, 1936, surgical removal of the breast, no enlarged nodes found in axilla. Alive and well six years after treatment (Fig. 5).

CASE II. M. C., aged forty-two, married; admitted April 11, 1935.

Complaint. Bulging of the right eyeball.

Diagnosis. Neoplasm of ethmoid.

Operation. Removal of tumor mass from the ethmoid, orbit and cranial cavity surrounding the sella turcica.

Pathology. Adenocarcinoma.

Treatment. Five gram pack, 6 cm. distance, irradiation of the left eye, left temple, left vertex and right temple 40,000 mg-hr. each. Treatment given one hour per session at daily intervals to alternate areas. Dose of 4,000 mg-hr.

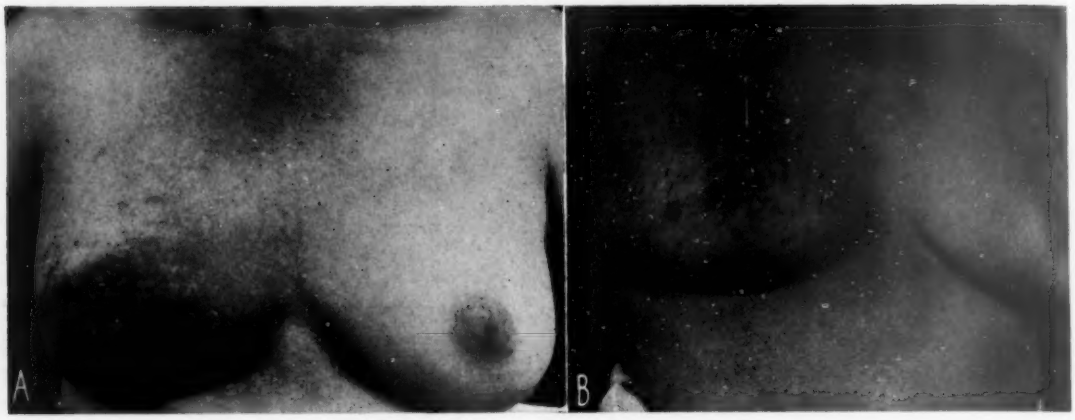


Fig. 5. Case I. *A*, inflammatory cancer of breast,before treatment. *B*, two years after radium treatment.

given per treatment (Fig. 6). Alive and well five years after treatment.

Case III, C. S., aged sixty-six, admitted Febbruary 2, 1933.

Complaint. Sore mouth and loss of weight.

Diagnosis. Carcinoma of tongue. Left margin of tongue opposite last third molar granular ulcer mass 3×3 cm., protrudes from tongue, moderate infiltration, bleeds readily. No palpable adenopathy.

Pathology. Plexiform epithelioma, transitional and squamous type.

Treatment. Radium pack to face and neck, 8×10 cm. portals, 6 cm. distance, alternate days, daily treatment one hour per session. Dose of 55,000 mg-hr. to each area; 7×2 mg. needles, 27 mm. for dose of 1,640 mg-hr. Died two years later, in 1935, from metastases and cachexia.

Case IV. S. K., aged fifty-nine, admitted September 20, 1932.

Complaint. Sore right side of mouth, immobility of tongue, lump in right side of neck for three years.

Diagnosis. Carcinoma floor of mouth.

Fig. 6. Case II. *A*, adenocarcinoma of ethmoid, before treatment. *B*, two years after radium beam therapy.

Pathology. Plexiform epithelioma.

Treatment. Radium pack over left neck 35,000 mg-hr., lower jaw 40,000 mg-hr. Right upper neck 45,000 mg-hr., totaling 120,000 mg-hr. Residual, 8 needles, 16 mg. for 120 hours, giving a dose of 1,920 mg-hr. Died of acute ruptured gallbladder, operation June 20, 1933. Local lesion healed: no adenopathy.

FIG. 7. Case v. Carcinoma of tongue, before and after treatment.

CASE V. F. O., aged fifty-six, married, admitted April 25, 1933.

Complaint. Sore mouth.

Diagnosis. Lesion on lateral border opposite second molar.

Pathology. Squamous cell epithelioma.

Treatment. Five gram radium pack, 6 cm. distance, to right lower jaw, 47,000 mg-hr. right upper jaw, 47,000 mg-hr.; left neck and jaw, 54,000 mg-hr., alternate areas, daily intervals, one hour at each session. Alive and well seven years after treatment (Fig. 7).

CASE VI. J. H., aged sixty-seven, married, admitted January 4, 1933.

Complaint. Sore mouth.

Diagnosis. Carcinoma of hard palate and alveolar ridge. Irregular, ulcerated lesion involving the posterior lower right alveolar ridge and extending to the upper alveolar ridge and adjacent hard palate.

Pathology. Squamous cell epithelioma.

Treatment. Five gram radium pack, 6 cm. distance, directed through the right lower jaw, 55,000 mg-hr.; left lower jaw, 50,000 mg-hr. Treatment given in daily doses, alternate areas, one hour per session. Alive and well seven years after treatment, working as a carpenter.

CASE VII. M. C., aged fifty-three, married, admitted July 3, 1933.

Complaint. Sore in mouth.

Diagnosis. Carcinoma of the mouth. Hard indurated ulcer anterior floor of mouth.

Pathology. Diffusely growing transitional cell epithelioma.

Treatment. Five gram radium pack to upper right neck, 49,000 mg-hr.; right lower neck, 49,000 mg-hr.; anterior jaw, 40,000 mg-hr. Marked reaction and epidermitis with desquamation. Treatment given in daily doses, alternate areas, one hour per session.

CASE VIII. H. C., aged fifty-nine, married, admitted May 19, 1932.

Complaint. Sore mouth.

Diagnosis. Carcinoma of mouth. Lesion of mouth, right lower buccal gingival groove, extending to the buccal mucosa.

Pathology. Squamous cell epithelioma.

Treatment. Five gram radium pack, 8 cm. distance, to right neck, daily treatments of 6,000 mg-hr.; total dose of 83,000 mg-hr.

Case ix. V. G., aged fifty-three, married, admitted August 22, 1933.

Complaint. Pain in left jaw and neck.

Diagnosis. Carcinoma of the soft palate, large ulcerated lesion involving the soft palate, extensive adenopathy left neck.

Pathology. Diffuse growing transitional cell epithelioma.

Treatment. Five gram radium pack, 6 cm. distance, through the left cheek, left neck and right cheek, 45,000, 45,000, 50,000 mg-hr. respectively. Treatment administered in daily doses, alternate areas, one hour per session.

Case x. B. K., aged fifty-four, married, admitted November 15, 1932.

Complaint. Hoarseness for six months.

Diagnosis. Carcinoma of larynx. Immovable cord with elevation of the cricoid cartilage. Roentgenogram showed swelling under the cricoid. No adenopathy.

Pathology. Squamous cell epithelioma.

Treatment. Five gram radium pack, right neck 60,000 mg-hr., left neck 55,000 mg-hr. Treatment given in daily doses on alternate areas, one hour per session. Patient alive and well eight years after treatment.

REFERENCES

1. Kaplan, I. I. Practical radium pack for bedside use. *Radiology*, 1931, *17*, 148–150.
2. Friedman, M., and Rosh, R. Protracted external irradiation in treatment of neoplasms of mouth and throat; comparison of x-rays, 5-gram radium pack, and 100-milligram radium pack. *Radiology*, 1935, *24*, 7–15.
3. Kaplan, I. I. Five-gram radium pack. Am. J. Roentgenol. & Rad. Therapy, 1936, *35*, 498–507.

DISCUSSION OF PAPERS BY DRS. SOILAND AND KAPLAN

Dr. Max Cutler, Chicago. I have been interested in radium beam therapy since 1924. Between 1924 and 1930 I had the opportunity of observing this method of treatment in the Memorial Hospital. Between 1931 and 1937, I used a 4 gram radium pack in the Tumor Clinic of the Michael Reese Hospital. Since 1933 I have used a 2 gram pack in the Hines Veterans Hospital and since 1938, a 10 gram apparatus in the Chicago Tumor Institute.

Although many forms of cancer have been treated, cancer of the mouth and upper air passages has been our chief interest. For the last two years the 10 gram unit in the Chicago Tumor Institute has been used almost exclusively in this group.

In the Chicago Tumor Institute, the staff has the privilege of Dr. Coutard's collaboration in the roentgen treatment of cancer of the mouth and upper air passages. This has presented to our group the unique opportunity of studying and comparing radium beam therapy and roentgen therapy in a specific group of cancers.

The almost insurmountable difficulties of drawing valid conclusions upon the comparative value of the two methods need no special comment to this audience. Among these difficulties I mention the most important, namely, the utter impossibility of knowing the radiosensitivity of a given cancer in spite of clinical and histological evidence. Confronted with this unknown factor, the difficulty of attributing a success or failure in a given case, to the therapeutic method is at once evident.

In 1932, the trend of roentgen therapy was in the direction of using divided daily doses over periods varying between thirty and forty days, administering a total dose adequate to produce a pronounced membrane over the lesion and surrounding tissues (epithelitis) and a superficial denudation of the skin (epidermitis).

In an effort to develop telecurietherapy to its greatest effectiveness, the dose which at that time was on the average of 30,000 mg-hr. at 10 cm. distance was rapidly increased to 100,000 and later to 120,000 mg-hr. to each of two fields. Thus the treatment of cancer of the tonsil, pharynx and larynx consisted of the administration of 2,000 mg-hr. in the morning to one side of the neck and 2,000 mg-hr. in the afternoon to the opposite side at 10 cm. distance, through a 10×10 cm. portal (1 mm. platinum filtration) with 4 grams of radium, so that the duration of each treatment was one hour. The total doses varied between 100,000 and 120,000 mg-hr. to each portal administered over a period of fifty to sixty days. Variations from this general principle consisted of diminishing the size of the portal or increasing the daily dose to 6,000 mg-hr. The best results were obtained in

cancer of the mouth, tonsil, pharynx, and larynx.

In 1938 the governing body of the National Research Council reported on 366 cases of cancer of the mouth, pharynx and upper air passages treated in the London Radium Institute and reached the following conclusion:

"We consider it to be established that telecurietherapy is a valuable form of treatment and that the results are sufficiently encouraging to justify an increase in the scope of the investigations so as to include cancer in other sites and also the use of still larger amounts of radium."

My experience is in accord with these conclusions. My views upon this method of treatment may be summarized as follows:

(1) Telecurietherapy is a highly useful form of radiation therapy.

(2) It has been found to be especially useful in cancer of the mouth and upper air passages.

(3) Improvement in apparatus permitting greater flexibility and more accuracy of administration has increased the effectiveness of telecurietherapy. There is room for still further developments in this direction.

(4) The use of larger quantities of radium (10 grams) overcomes an important obstacle to effective treatment and opens new and more promising avenues of research.

(5) Since telecurietherapy has never yet been utilized in accordance with the principle and technique of the most recent developments in radiation therapy, it is believed that the application of the new advances to telecurietherapy will offer new possibilities of important progress. These researches are now under way in the Chicago Tumor Institute with a 10 gram radium unit.

Relative Merits of Telecurietherapy and Roentgen Irradiation. Despite the fact that roentgen therapy and telecurietherapy have been used for many years the comparative therapeutic value of the two methods is not known with certainty. There are many physical and some biological data available on this question but a final opinion will require a comprehensive and critical clinical study.

In order to compare the value of roentgen therapy and telecurietherapy it is first necessary to make a comparison of two groups of patients suffering from comparable lesions, and treated under conditions in which all the physical factors except wave length are the same.

It is quite possible to control the physical factors in such an experiment. It is much more difficult to be certain that the lesions are comparable. However, with an adequate clinical material and with careful and critical selection of cases, this difficulty can be sufficiently overcome to permit valid conclusions. An experiment of this type is now under way in the London Radium Institute where it is proposed to compare the clinical value of 200 kv. roentgen therapy and telecurietherapy. Similar studies have been inaugurated in the Chicago Tumor Institute.

EFFECTS OF ROENTGEN IRRADIATION ON EXPERIMENTAL HYPERTHYROIDISM*

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THERE has been considerable discussion as to the efficacy of the roentgen treatment of clinical hyperthyroidism. If it were possible to conduct adequately large controlled observations of the roentgen treatment of this disease in human subjects, the answer to this question would soon be forthcoming. Unfortunately, no such series has been or is likely to be conducted, and therefore it is necessary to answer this question experimentally, if possible.

By injecting thyrotropic fractions of anterior pituitary substance into guinea pigs, it is possible to produce a hyperthyroidism closely simulating the natural disease. This experimental hyperthroidism can be maintained for about three weeks, after which time the animals become refractory to the injections and the disease disappears spontaneously. It is claimed by those[4] who regard irradiation as an efficacious method of treatment in patients that such treatment for about one month will alleviate symptoms of the disease in a high percentage of cases. However, irradiation of the disease in guinea pigs for a similar length of time is impractical in view of the brief course of the experimental hyperthyroidism. Therefore, it would be necessary to shorten the time of treatment to a period of about seven to ten days. Accordingly, we irradiated 25 guinea pigs with hyperthyroidism under controlled conditions, and present a summary of the results in this report.

METHODS

Using radium irradiation of the thyroid, *prior* to injection of the thyrotropic hormone, Eckert *et al.*[1] found that such irradiation definitely impaired the ability of the thyroid gland to manifest its usual stimulation. In order to confirm or disprove these results, we irradiated guinea pigs both before the induction of experimental hyperthyroidism and simultaneously with it. Virgin female guinea pigs weighing about 200 grams were injected daily subcutaneously with from 5 to 25 mg. of a flavianic acid extract[2] of beef anterior pituitary glands. These guinea pigs developed a prompt hyperthyroidism, reasonably proportional to the dosage of the extract. Metabolic rate determinations were made once or twice weekly with a modification of Tainter and Rytand's[3] apparatus. Most of the experiments were continued for a period of four weeks, at which time the guinea pigs were killed and autopsied. In one experiment an additional period of four weeks was given in order to see what late histological changes might be present.

The roentgen treatment was given three times a week for about six treatments, the first treatment being usually on the third day of injection. The thyroid gland in guinea pigs lies more cephalad than it does in humans and care was taken that the beam of roentgen rays was accurately directed to the entire glandular area. The total dosage applied to the thyroid ("tissue dose") varied from approximately 1,600 r in the first group of animals to 2,400 r in the third group. We realize that the dosage reported in the literature as being efficacious in human hyperthyroidism varies within wide limits but, as previously reported by some of us,[4] we regard approximately 1,800 r as being a desirable dosage for clinical cases, over a period of about four weeks.

The technical factors were as follows: For the first group of animals, 50 kv., filter 2.5

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mm. aluminum, target-skin distance 2 cm., field 2.5 cm. diameter, dosage 330 r, measured in air, every second day to the thyroid anteriorly for six doses (estimated thyroid dose 1,600 r). For the second, third and fourth groups of animals, 50 kv., 2 ma, filter 1.0 mm. aluminum, target-skin distance 4 cm., field 3 cm. diameter, dosage approximately 500 r, measured in air, every second day, to the thyroid anteriorly, for five or six doses (six in the second and third groups of animals, five in the fourth group —estimated thyroid dose approximately 2,400 r and 2,000 r respectively). The thyroid dose was estimated as follows: The gland lies about 5 mm. beneath the skin of the guinea pig's neck, anteriorly; the back-scatter with the radiation mentioned is 12 per cent, and the depth dosage at 5 mm., 70 per cent. The guinea pigs were irradiated in the supine position, being held in conventional wooden boxes, their heads immobilized by sponge rubber blocks.

Four experiments were made, three in the early spring months and one experiment in the summer months, using half the animals for controls each time. The first and second groups consisted of irradiation during the hyperthyroid state (i.e., during the period of hormone injection) in order to determine the immediate effect of treatment on that hyperthyroidism. The third experiment consisted of two parts, one in which the guinea pigs were irradiated during the hyperthyroid state (the "standard" experiment), and one in which they were irradiated prior to induction of hyperthyroidism, in order to determine the degree of subsequently induced hyperplasia, and to check Eckert's findings. The fourth experiment was made after allowing an interval of from six to eight weeks to elapse between irradiation and injection of thyrotropic hormone in order to see the degree of hyperthyroidism producible in potentially depressed or "fibrosed" glands. The results obtained are summarized in Table I.

TABLE I

	Experiment	Number of Guinea Pigs	Dose of Thyrotropic Hormone (mg.)	Average Peak Metabolism	Duration of Elevated Metabolism (days)
I	Control	2	25	+30	21
	Irradiated during hyperthyroidism	2	25	+65	30
II	Control	5	25	+50	28
	Irradiated during hyperthyroidism	7	25	+63	24
III	Control	4	5–10	+65	30
	Irradiated during hyperthyroidism	6	5–10	+50	28
	Irradiated before hyperthyroidism	5	5–10	+55	20
IV	Control	6	5–10	+60	15
	Irradiated before hyperthyroidism	5	5–10	+62	16

METABOLIC EFFECTS

It is seen that, despite fairly large dosage with roentgen rays, no consistent effect on metabolic rate was produced.* The usual reactions to the hormone such as tachycardia, irritability and enlarged thyroid were about as marked in the irradiated animals as in the controls. However, the degree of hyperthyroidism produced by "regular" (25 mg.) dosage of hormone was quite severe, analogous perhaps to the fulminating form of Graves' disease seen in

* The roentgen-ray dosage was sufficient to epilate and occasionally partly destroy the skin of the neck over the thyroid area.

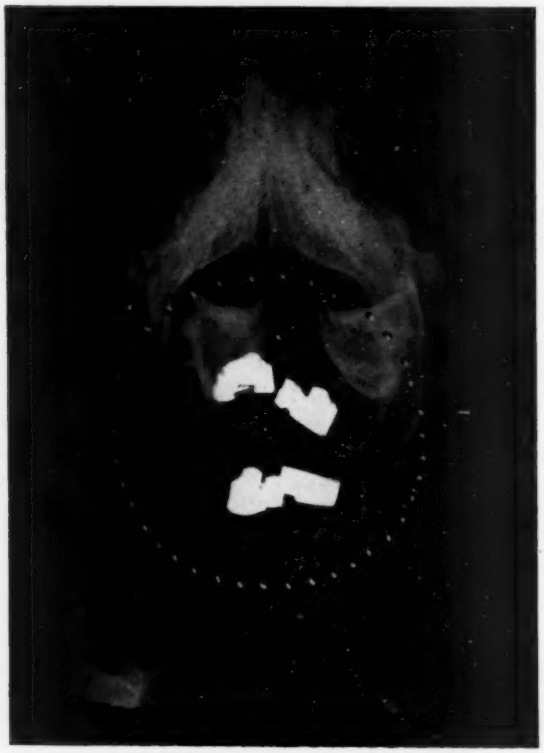

FIG. 1. Roentgenogram of guinea pig's neck showing the location of the thyroid glands (clips at the upper and lower ends of each gland) and confirming the location of the beam of therapeutic roentgen rays, the white dots indicating the border of the epilated zone.

man. When the dose of hormone was low and a less severe degree of hyperthyroidism was produced, a slight but not definitely significant lowering of metabolism occurred.

It is to be noted that each set of experiments was begun with from 10 to 20 guinea pigs but, despite routine care and all precautions, there was a fairly high spontaneous mortality in both the treated and the control animals. The result was that the number of tests followed to absolute completion was not large, actually 42 in all.

HISTOLOGICAL CHANGES

The histological changes produced in the normal, resting thyroid by ordinary doses of radiation are known to be very slight. However, in the hyperplastic or hyperactive gland they are believed to be significantly depressive. The degree of reaction may be judged by loss of cellular staining quality, enlargement of nuclei, pyknosis, etc. The usual criteria of thyroid activity are based on the height and condition of the epithelium; the size and shape of the acini; the amount and condition of the colloid; and interacinar changes such as lymphocytic infiltration.

In the first group of guinea pigs (thyroid dose approximately 1,600 r during a period of ten days) the thyroid glands were examined about seven days following conclusion of the roentgen treatment and seven days following the last hormone injection. These glands showed very slight scarring but otherwise appeared like the control glands.

In the second and third groups (thyroid dose 2,400 r in fourteen days), the glands were examined in some cases at the end of treatment and, in some, one month following completion of the roentgen treatment and hormone injections. In those guinea pigs killed at the end of treatment the glands showed edema, slight cellular infiltration and no fibrosis. In those killed about one month later there were dema, moderate cellular infiltration and a slight increase in fibrous tissue. The epithelium showed no gross changes. The other changes characteristic of hyperthyroidism were absent or minimal. Therefore, the findings support the well-known fact that the histological changes produced by irradiation of the type given take several weeks to manifest themselves in the thyroid gland and are not very marked.

In the fourth group of guinea pigs (thyroid dose approximately 2,000 r in fourteen days), the irradiation was given eight weeks prior to injection of the hormone. The hormone was continued for three weeks. Glands from two animals sacrificed just before the injections were started showed inactive epithelium with some scarring around the gland, while the glands from one animal at the conclusion of the hormone injections were smaller and less active than from a non-irradiated control at the same time.

There was no histological evidence of so-called stimulation of the thyroid by the irradiation, as is sometimes alleged by clinicians to occur in human cases; nor was the treatment productive of "dense adhesions" about the gland. On the other hand, there was no marked depression of cellular activity produced in the severely hyperplastic glands in this series.

DISCUSSION

The immediate inference from the results obtained might be that the type of experimental hyperthyroidism which can be produced in guinea pigs by injection of thyrotropic hormone cannot be significantly influenced by roentgen irradiation, either during or prior to its induction. However, this form of hyperthyroidism is of an intense type, and it is conceded even by ardent advocates of radiation therapy of Graves' disease that its severe form is not usually curable by irradiation alone. Furthermore, the duration of the experimental disease is so short that it is difficult to duplicate what may be regarded as desirable spacing of treatments in the experimental work. Therefore, it should not be concluded from this work that clinical hyperthyroidism, in general, is not amenable to properly given irradiation, Conversely, we could not show any immediate or early histological changes to support the contention that alleviation can be produced in severe cases.

CONCLUSION

The type of experimental hyperthyroidism which can be produced in guinea pigs by injection of thyrotropic hormone cannot be significantly influenced by roentgen irradiation either during or prior to its production.

REFERENCES

1. Eckert, C. T., Probestein, J. G., and Galinson, S. Radiation of thyroid; experimental study in radiosensitivity of thyroid. *Radiology*, 1937, *29*, 40–44.
2. Evans, H. M., Meyer, K., and Simpson, M. E. *Memoirs Univ. Calif.*, 1933, *11*.
3. Tainter, M. L., and Rytand, D. A. Simple apparatus for metabolic measurements on small animals. *Proc. Soc. Exper. Biol. & Med.*, 1934, *32*, 361–363.
4. Newman, W. W., and Garland, L. H. Non-surgical treatment of hyperthyroidism complicating heart disease. *Surg., Gynec. & Obst.*, 1938, *67*, 632–639.

RADIODERMATITIS AMONG PHYSICIANS

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IN 1936 one of us (Leddy) reported that the main causes of radiodermatitis among 55 physicians who came to the Mayo Clinic for advice between the years 1919 and 1934 seemed to be ignorance and carelessness. The present report is a continuation of that study, and extends from 1934 to 1939. During this period at least 80 additional physicians suffering from injuries caused by irradiation were encountered at the Clinic. Before the data found in this second group are presented, a brief review of the first study will be made.

The study referred to limited "actinodermatitis," as employed in that study, to any injury of the skin manifesting itself as severe telangiectasis, keratosis, acute or chronic ulceration, epithelioma, or any combination of these conditions. Early dermatologic changes such as erythema, fissured nails, rough skin, slight telangiectasis or mild pigmentary changes, atrophy of the fat pads, or hangnails were excluded because of the possibility that other agents might have been the causes.

All the physicians in these studies, with the exceptions to be noted, regarded roentgen rays as the cause of their injuries. In the first group of 55 physicians 18 suffered from epithelioma; all the lesions had developed at the site of the radiation injury, and 15 more had benign acute or chronic ulcers. Thus, a total of 33, or 60 per cent of the members of that group, had the most severe types of cutaneous injury. The most common sites of the injury were the dorsa of the fingers and hands, and the left index finger was the most frequently and most severely damaged. The face and the eyes were surprisingly free from injury.

In that group of 55 physicians, 7 had been injured while they were receiving roentgen treatment which had been administered by persons who were not roentgenologists and one had been injured during treatment by a radiologic specialist. Two other physicians had been injured, one by the handling of radium and the other during the course of experimental determination of roentgen dosage. The remaining 45 patients sustained injury during roentgenoscopy which they had employed chiefly in the reduction of fractures or in the localization of foreign bodies. Of the 45 physicians who were injured during roentgenoscopy, only one was a radiologist. This study pointed out the grave risk incurred by those who use roentgen rays only casually and, therefore, inexpertly.

In the present study of 80 physicians (considered according to the same criteria) suffering from radiodermatitis who came to the Clinic from 1934 to 1939, 21 had epitheliomas and 9 had benign ulcers. Thus a total of 30 physicians, or 37.5 per cent, had ulcers on their hands arising from the use of roentgen rays.

In all, the hands were the site of injury in 70 instances; in 41 cases the left hand was injured, in 23 both hands were injured, and in 6 the right hand was injured. The face was injured in 5 cases, in 3 of which the injury presumably was the result of roentgenoscopy which also injured the hands; 2 facial injuries were caused by treatment inexpertly administered for acne and a nevus, respectively.

Fifteen physicians were injured while they were receiving roentgen treatment. Seven of these were treated by persons who were not roentgenologists; 6 had prescribed their own treatment which had been ad-

ministered by their office girls (2 of these patients were roentgenologists) and 2 other physicians were treated by roentgenologists. One of the physicians who was treated by a roentgenologist received postoperative treatment for carcinoma of the thyroid gland and the other received therapy for hypernephroma. Both sustained comparatively mild injuries and no ulceration.

There were only 5 roentgenologists in this group of 80 physicians. Two of these physicians had sustained their injuries while they were undergoing treatment, for psoriasis in one case and for carcinoma of the thyroid gland in the other case. Another roentgenologist was a pioneer in the field, having started in 1905. The remaining two had been roentgenologists for many years.

In the group of 65 physicians who were not injured by irradiation received during treatment, 46 ascribed the cause of their injuries to roentgenoscopy, and 6 to the making of roentgenograms. In 13 instances no specific cause was mentioned, except that all these 13 physicians said that they "did a little x-ray work."

If the two groups are compared and the results combined, some interesting observations may be made. Actually, more physicians came to the Clinic for advice regarding roentgen-ray dermatitis from 1934 to 1939 (80) than from 1919 to 1934 (55). The figure of 80 is out of proportion to the total registration for these two periods. This definite increase of radiodermatitis may be referable to one of three factors: (1) more physicians may be coming to the Clinic for medical consultation, (2) more physicians may be acquiring radiodermatitis, or (3) it may be that more instances of actinodermatitis are being diagnosed. The third factor does not seem to be the logical cause and it may be concluded that more physicians who have roentgen-ray dermatitis are being encountered because more of these lesions are appearing. Whether the injuries described resulted from cumulative overdoses for a period of years or whether they resulted from relatively recent overdoses cannot be answered by the data which we have used for this study. Nevertheless, the fact remains that at the Mayo Clinic an increasing number of physicians suffering from roentgen-ray dermatitis is being encounterd, and we wonder what the recent experience of other clinics may be.

Codman in 1902 reported 167 cases of accidental roentgen-ray burns and in 53 cases, or 31 per cent, the lesions were sustained by persons working with roentgen rays. Saunders and Montgomery in 1938 reported on 259 cases of chronic roentgen-ray dermatitis and radium dermatitis, and in 26 cases, or 10 per cent, the lesions afflicted physicians and dentists. The hands were the most common sites of injury among the 26 patients. Duffy, in 1939, writing on keratoses and carcinoma referable to irradiation, stated that the majority of patients whom he had observed were radiologists or roentgenologists who had been working with radium and roentgen rays for a long period. Members of this group are numerous and the number seems to be increasing; however, Duffy said such an increase may be only apparent, because he was encountering more victims of the late effects of irradiation than others. He also stated that he was discovering some lesions among the younger generation of radiologists. Witwer and Leucutia in 1940 reported 28 malignant neoplasms observed from 1922 to 1938 as being caused by irradiation and found in the group of patients so affected 1 radiologist, 4 industrial surgeons, and 3 dental surgeons.

In the original group reported on by one of us (Leddy), and in the present study also, the number of persons injured who were not roentgenologists far exceeded the number of roentgenologists. Of the 55 physicians in the first group, only one was a roentgenologist, and in the present study 5 physicians out of 80 were roentgenologists. This striking preponderance of injured persons who were not roentgenologists probably must in general be referable either to lack of proper roentgenologic equipment, or to deficient knowledge; pos-

sibly, in some cases, it may be caused by insufficient experience or by carelessness.

Sixty per cent of the members of the first group had sustained serious injury, for example, epithelioma or formation of ulcer, whereas only 35 per cent of the members of the present group had sustained serious injury to the skin. This difference *may* indicate that physicians are seeking medical advice earlier than usual. In both groups the hands, and in particular the left hand, were the most frequent sites of injury. Reporting of this situation agrees well with reports of situations made by others, and the reason for the preponderance of this situation will be shown shortly.

On investigation of the causes of injury, we found four main ones. The first was lack of proper roentgen-ray equipment. Yet superiority of roentgen-ray equipment in itself confers no expertness on the operator. It is the individual, not the machine, that is important. Duffy stated that in many of his cases the condition apparently was caused by physicians' testing old-fashioned gas tubes. Stenstrom and Vigness, in 1939, during the course of calibration of many roentgen-ray generators in use at the time, said they found that in the arrangement of these generators, especially in the case of superficial, low voltage machines, much in the matter of protection was lacking. All the roentgen tubes were situated in open bowls and often the control cabinet was placed in the same room as that in which the tube was situated. The output of these machines varied as much as 150 per cent for unfiltered radiation at 100 kv. (peak) and a 12 inch target to skin distance. For filtered radiation the output varied as much as 100 per cent.

The second, but probably minor, factor to be considered is carelessness in the handling of radium and radon. Obviously, all such material should be kept in lead-lined containers until just prior to use. The use of long-handled forceps in the handling of radioactive substances does much to reduce the amount of radiation which reaches the hands. A careless or clumsy operator will use his fingers rather than forceps, and will thereby eventually injure his fingers.

The third factor to be considered is needless exposure of the hands during the making of roentgenograms. Dentists in particular are accustomed to hold films in the patient's mouth while an exposure is made. Physicians often expose their hands while injecting radiopaque material into sinus tracts or while holding a cassette when a roentgenogram of a seriously ill patient is made with portable apparatus, or by indifferently holding an innocent-looking radium applicator. Refinements in technique, and especially care, will eliminate this pointless exposure of the operator.

The fourth and the most important factor which causes injury is incorrectly done roentgenoscopy. In both studies carried out at the Clinic, as in the studies of others, roentgenoscopy was the most important cause of injury. For 45 out of 55 members of the original group, roentgenoscopy was definitely labeled as the causative factor. Surprisingly enough, one of us (Leddy) in the original study found that not one physician of the forty-five who received injury during roentgenoscopy wore lead-rubber gloves regularly throughout most of his examinations. Generally, lead-rubber gloves were worn only after permanent injury to the skin had been received. Among the 46 physicians in this present report who were injured doing roentgenoscopy, not one regularly wore lead-rubber gloves. Thirty-three of them used no protective devices at all. Such figures certainly point to shocking carelessness and indifference.

Stevenson, in writing on protection during roentgenoscopy, divided roentgenoscopy into five separate parts: (1) in reduction of fracture, (2) in the search for foreign bodies, (3) in "chest diagnosis," (4) in "stomach diagnosis" and (5) in "small bowel and colon diagnosis." The first of these, roentgenoscopy in the reduction of fractures, is the most frequent cause of injury in the two groups presented herein, as well as in the reports of others. Stevenson and one of us (Leddy), in 1937, writing on the danger

of reduction of fractures under the roentgenoscope and methods of protection against such danger, emphasized the fact that in the reduction of a fracture the surgeon's hands usually lie under the fractured extremity and are closest to the roentgen tube. In this manner the surgeon's fingers and hand actually have received a severe injury in the reduction of a single fracture. Stevenson and one of us (Leddy) also pointed out that the erythema time to the dorsa of the operator's fingers when the fingers are resting on the table top under conditions of 80 kv., 6 ma., 16 inch distance and a half inch pine veneer table top in the center of the field without any filter (conditions closely approaching those in actual practice), is seven minutes and forty-five seconds. For greater safety, a technique consisting of utilization of 55 kv., 3 ma., 2 mm. of aluminum filtration, 16 inch tube table top distance and a table top of a half inch pine veneer, which increases the time for an erythema dose to ninety-five minutes and yet permits facile manipulation of the fractured limb under the roentgenoscope, was suggested. It was also strongly urged that reduction should be done with speed and with a short period of activation of the tube. Fingers should be kept outside the central beam, particularly when lead-rubber gloves are not worn, and use should be made of the protection afforded by the thickness of the extremity being examined. Reduction of fractures under the roentgenoscope was strongly condemned, unless the operator carefully measured the dose he received, or unless he was under the direct supervision of an experienced roentgenologist, or unless he used *all* recommended protective devices. Substitution for the roentgenoscope of some method of making roentgenograms rapidly in the operating room was advised.

The second division, roentgenoscopy in the search for foreign bodies, is the next most common cause of roentgen-ray injury. In this case the patient's body, or a part of it, usually intervenes between the tube and the examiner's hands, and to some extent reduces the dose received by the hand. All the measures recommended for use in reduction of fractures under the roentgenoscope are to be recommended for this procedure also.

The third division, roentgenoscopy in examination of the thorax, was not a major cause of injury in our groups. Measures to be recommended are speed in examination, use of lead-rubber gloves, protective devices, use of as small a portal as convenient and, finally, keeping the patient's body between the operator and the tube at all times, especially when the patient is turned.

The fourth and fifth divisions, roentgenoscopy in examination of the stomach, and in examination of the small bowel and colon, will be grouped together because they are concerned in the field of gastroenterology, in which the roentgenoscope is almost indispensable. Cilley, Kirklin and one of us (Leddy), working on both these subjects, recommended speed of examination, utilization of the protective power of the barium-filled viscus, use of the smallest possible beam, keeping of the examining hand out of the beam as far as possible, and use of protective devices, such as rubber gloves, by the inexpert operator. Stark has devised a spoon of balsa wood (a modified Holzknecht spoon) attached to the center of the screen which can be pushed in for a distance of 5 cm., which, as determined by Cilley, Kirklin and one of us (Leddy), is the average distance of compression required to depress the abdominal wall to produce visualization of the mucosal relief of the stomach.

Åkerlund, writing on the measures used in Sweden for protection against roentgen irradiation in roentgenoscopy, divided them into two categories. The primary protective measures against irradiation included use of filtration and a primary cone with a variable opening. The second protective measure included a large roentgenoscopy screen, head protector, wing-shaped arm shields, bowl-shaped hand shields, lead gloves, protective stool, protective table and foot shields.

We think that the evident increase of roentgen-ray dermatitis among physicians can be minimized only by the use of proper equipment and precise technique, protective devices, and by experience and knowledge of those engaged in using roentgen rays, radium or radon, no matter how infrequently. Of the measures for increasing safety, education is the most valuable. The fact that 115 physicians had self-produced radiodermatitis and that 39 of them produced cancers in themselves by using their own apparatus, no matter how well, merits very serious consideration by those who think that roentgenologic technique is easily acquired and is safe. The risks involved in the casual use of the roentgenoscope by those without special training cannot be emphasized too strongly, for mechanical equipment cannot be substituted for mental equipment in any branch of roentgenology.

REFERENCES

1. ÅKERLUND, Å. Strahlenschutz der jetzigen schwedischen Durchleuchtungsgeräte. *Acta radiol.*, 1935, *16*, 379–389.
2. CILLEY, E. I. L., LEDDY, E. T., and KIRKLIN, B. R. The dangers of roentgenoscopy and methods of protection against them. III. The protective power of the barium-filled stomach. AM. J. ROENTGENOL. & RAD. THERAPY, 1935, *33*, 88–92. V. Some considerations of the "dose" received during examination of the colon. *Ibid.*, 1935, *33*, 787–792. VI. Some studies of the "doses" received by the body of the examiner. *Ibid.*, 1935, *34*, 241–247
3. CODMAN, E. A. A study of the cases of accidental x-ray burns hitherto recorded. *Philadelphia M. J.*, 1902, *9*, 438–442.
4. DUFFY, J. A. Irradiation keratoses and carcinoma. AM. J. ROENTGENOL. & RAD. THERAPY, 1939, *42*, 540–544.
5. LEDDY, E. T. The causes of roentgen-ray dermatitis among physicians. AM. J. ROENTGENOL. & RAD. THERAPY, 1936, *36*, 510–511.
6. SAUNDERS, T. S., and MONTGOMERY, H. Chronic roentgen and radium dermatitis; an analysis of 259 cases. *J. Am. M. Ass.*, 1938, *110*, 23–28.
7. STARK, J. D. Protection during gastrointestinal roentgenoscopy. AM. J. ROENTGENOL. & RAD. THERAPY, 1938, *39*, 480–482.
8. STENSTROM, K. W., and VIGNESS, I. Scattered radiation and variation of roentgen output of x-ray generators in practice. *Minnesota Med.*, 1939, *22*, 517–520.
9. STEVENSON, C. A., and LEDDY, E. T. The dangers of reducing fractures under the roentgenoscope and methods of protection against them. AM. J. ROENTGENOL. & RAD. THERAPY, 1937, *37*, 70–82.
10. STEVENSON, C. A. Protection in fluoroscopy. *Texas State J. Med.*, 1939, *35*, 12–15.
11. WITWER, E. R., and LEUCUTIA, T. Late sequelae of divergent biologic skin effects produced by roentgen irradiation with varying voltage. *Radiology*, 1940, *34*, 24–27.

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PRIMARY TUMORS OF THE LUNGS

ROENTGEN DIAGNOSIS AND THERAPY. REPORT OF 130 CASES

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IT IS well known that primary tumors of the lungs in most cases are carcinomas. Histologically the most common form is the bronchial or epidermoid carcinoma. Its origin is in the lining cells of the bronchi. The other form originating from the lining cells of alveoli (adenocarcinoma) is not met with so often. The tumors of the lungs are mostly recognized only when large primary and secondary changes are already present.

This is principally due to many polymorphous clinical symptoms in the course of primary carcinoma of the lung, which is always accompanied by a variety and variability of pathologic and anatomic changes.

In the beginning the disease may be latent and clinical symptoms almost absent. Then suddenly may appear the symptoms of pneumonia, abscess of the lung, pleurisy, grippe, mediastinitis or tumors of the esophagus.

We once had a case of proved primary carcinoma of the lung which had for a rather long time the clinical diagnosis of paratyphoid. Primary pulmonary carcinoma is sometimes manifested by changes in the peripheral nervous system, by stricture of the vagus nerve with symptoms in the gastrointestinal tract, etc.

In some cases metastases in the brain give a semblance of a primary tumor of the brain or of meningo-encephalitis, and metastases in the spine cause a false diagnosis of spondylitis. Some patients, with primary pulmonary carcinoma, after a useless treatment with pneumothorax die of tuberculosis and some in neurologic clinics. Part of these mistakes are certainly caused by the insufficient use of the most valuable and easy method of diagnosis, roentgenoscopy of the chest. But although this method is of great value, it is also well known that the roentgenologic aspect of carcinoma of the lungs is like that of several other diseases. Therefore, to avoid occasional errors the diagnosis must be verified by microscopic examinations and other special investigations.

Of course the autopsy gives a clear idea of the pathologic process and usually verifies the clinical diagnosis. But its deficiency is that it gives only the picture of the final development of the pathologic process. The necessity of obtaining a microscopic confirmation of the clinical diagnosis of pulmonary cancer is best satisfied by means of bronchoscopy accompanied by biopsy.

Another valuable method of investigation is the analysis of the microscopic findings in the sputum, which enables a differentiation from tuberculosis or actinomycosis, and often can even reveal the presence of a tumor.

The importance of the examination of the sputum microscopically was established long ago, but nevertheless many authors do not rely upon the possibility of finding in sputum the elements of neoplasm. These findings are often considered as casual and accompanying only a vast and advanced destruction of the tumor tissue. But a study of a series of many cases in the Ukrainian State Roentgenologic and Oncologic Institute in Kharkov showed the great value of this method of investigation in the diagnosis of malignant tumors of the lungs.

The second problem which arises, whether the tumor in question is primary or metastatic, may be solved by study of the roentgenograms of the lungs, compared with clinical symptoms. Difficulties can arise in cases with a large shadow in the pulmonary field due to pleural effusion or

in cases with a round shadow. But in practice, if we have suspicious roentgenological signs of a primary pulmonary carcinoma, together with clinical symptoms and findings of elements of malignant neoplasm in the sputum, we have sufficient evidence of primary tumor of the lung, often even without the aid of bronchoscopy.

During the last ten years we had in the Ukrainian State Roentgenologic and Oncologic Institute 130 cases of primary carcinoma of the lung. In this series 2 cases were afterwards proved benign tumors (fibroma of the lung); 3 cases sarcoma, and 1 case lymphangitis sarcomatosa. All the remaining 124 cases were classified as primary carcinoma of the lung (including the local lesions of the principal bronchi).

In our 130 cases only 9 were in females and 121 in males. The majority were in the age from forty to fifty (48 cases) and from fifty to sixty (43 cases). The youngest patient with pulmonary cancer was twenty-six and the oldest seventy-three.

Seventy-one cases were proved: 26 histologically and 45 were verified by microscopic findings in sputum. In 8 cases proved by autopsy elements of malignant neoplasm were found in the sputum during life. Thus 53 cases out of 71, or 58 per cent, where microscopic examinations were made were verified by sputum study.

Out of 26 cases proved histologically, in only 16 was an autopsy performed. In 9 cases the diagnosis was made by means of a biopsy of a metastatic gland or at operation, and in 1 case upon the histologic findings of a piece of expectorated tissue.

In 59 cases the diagnosis was not verified by the microscopic findings and the disease was diagnosed principally by roentgenologic data. All clinical symptoms and laboratory findings were carefully collected as well as the histories of illness, and information of relatives of our patients were carefully collected and noted.

The following roentgenologic signs were considered of importance: a dense solitary shadow on one side of the chest, displacement of the organs of the mediastinum during inspiration, rise of diaphragm on the side of the lesion, paradoxical movement of the diaphragm, metastases in bones, lymph nodes and other organs.

In this series of 59 cases, in 20 cases metastases were found; in 3 cases bronchography revealed a complete stricture of the bronchus, 3 cases were proved by bronchoscopy without biopsy, and in 1 case a large tumor was discovered during operation. This tumor was classified macroscopically by the surgeon as a sarcoma. In all these 59 cases there were no clinical symptoms or laboratory findings of tuberculosis, actinomycosis, lymphogranulomatosis or abscess of the lung. With regard to lues, we will only say that there must be absolute proof of this diagnosis; in addition, it is a rare condition.

A supposed clinical diagnosis of tumor of the lung, before roentgenologic investigations and before microscopic findings in sputum, was made only in 18 per cent of cases. For the series of 71 confirmed cases the percentage was higher, being 24. All other patients were admitted to the Institute either with no diagnosis, or with a false diagnosis, which was not confirmed in the Institute. If we look at Table 1 we may understand this fact. This table shows the clinical symptoms which were observed in our patients. It is evident that all these clinical symptoms, considered alone, are not specific, and only when compared with roentgenological and laboratory findings do they give a picture of the disease and its development which is of importance in the diagnosis of pulmonary carcinoma.

One of the principal clinical symptoms for an early diagnosis is a severe, irritating, "causeless" cough, especially in old persons, and pain in the chest, especially during the later periods of the disease. The blood picture shows lymphopenia and a neutrophile leukocytosis. Anemia is also often a symptom. An acute onset of the disease with high fever is not against a diagnosis of tumor. Generally clinical symptoms depend on the localization of the lesion, its size and different complications,

which often accompany primary carcinoma of the lung and which depend on the period at which the patient applies to the clinic.

But the roentgenologic diagnosis also was sometimes the source of error. In 22 per cent of cases proved microscopically, at autopsy, biopsy and from findings in the sputum, no definite roentgen diagnosis was obtained, or this diagnosis was incorrect.

In 2 cases peribronchitis and bronchiectasis were diagnosed, while the autopsy showed a bronchogenic carcinoma arising from the right lower principal bronchus in 1 case and from the upper left bronchus in the other. In these cases no bronchoscopy was performed. In 1 case, a male aged twenty-nine, miliary tuberculosis was diagnosed and the autopsy revealed a primary miliary carcinosis. In 2 cases of fibrosarcoma surgical operations were performed, supposedly for echinococcus cyst of the lung. In the third case no operation was performed and the diagnosis was confirmed by biopsy of a metastatic gland. In 1 case of primary carcinoma of the lung an echinococcus cyst of the left lung was erroneously diagnosed from the roentgenogram.

In another case (a male, aged thirty-nine) there was in the roentgenogram a large shadow covering the whole right lung due to the massive effusion in the pleural region. No displacement of organs of the mediastinum towards the lesion was observed. The roentgen diagnosis was doubtful. Only several consecutive microscopic findings in the sputum showed the elements of cancer, and no signs of tuberculosis, abscess or actinomycosis were found.

In 1 case for a long time the diagnosis was abscess of the lung, and only after the analysis of many roentgenograms and microscopic findings in the sputum was the correct diagnosis of primary carcinoma of the lung established. This diagnosis was verified by autopsy findings.

TABLE I

CANCER OF THE LUNG

Clinical Symptoms in Percentage to the Total Number of Cases

Cough		Sputum		Pain	Weakness	Loss of weight	Dyspnea	Fever
Dry	With expectoration	Nonhemorrhagic	Hemorrhagic					
14.0	75.4	30	45	73	28.7	50.8	27.1	32.0

Onset		Grippe in the History	Blood Test	
Sudden	Progressive		Hemoglobin under 50%	Neutrophile Leukocytosis
59	41	25	45	25

In 2 cases of a combined disease of tuberculosis and carcinoma of the lung the roentgen findings were doubtful. It is interesting to note that in 1 of these cases (Fig. 1) a large destructive cancer was found near the hilum and tuberculosis was not verified macroscopically, although tubercle bacilli were found in the sputum a short time before the death of the patient.

In 2 cases we were obliged to renounce our primary diagnosis of pulmonary tumor, based upon roentgenograms, because further clinical symptoms and analysis of subsequent roentgenograms obtained during the later period of over two years in one case and over four years in the second and sputum findings, allowed a diagnosis of chronic pneumonia. In the second of these cases good results were obtained by roent-

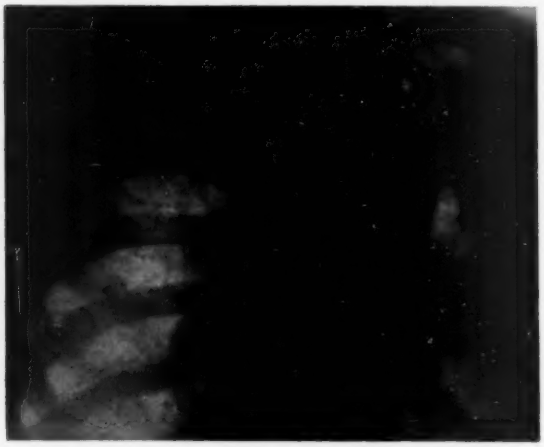

FIG. 1. (No. 34723) M. K., male, aged forty-nine. Since 1925, following pneumonia, he has had clinical symptoms of pulmonary tuberculosis, with aggravation each spring. In July, 1930, considerable hemoptysis and tubercle bacilli in the sputum. On October 13, 1930, the patient was operated on because an echinococcus cyst of the lung was suspected. A tumor of the lung was revealed during the operation. In this roentgenogram taken on March 4, 1931, a large dense oval shadow is seen near the left hilum. Inside the shadow there is a cavity filled with fluid. Autopsy revealed an extensive carcinoma of the left lung.

gen therapy. The patient felt much better and the pathologic shadow nearly disappeared in the roentgenograms.

In 1 case the diagnosis based on clinical symptoms and on the analysis of roentgenograms was "primary lobar carcinoma" of the upper part of the right lung, with metastases in the posterior mediastinum. Autopsy revealed a primary hypernephroma of both kidneys with metastases in the lung and mediastinum.

In another case, a female aged thirty-five, a rapid growth of a tumor in the soft part of the thigh was observed. In the puncture fluid, some cells suspicious of sarcoma were found. In two months the patient began to cough, but physical examination, findings in the sputum and roentgenograms were negative. No bronchoscopy was performed. In seven months multiple round shadows of metastases in the lungs were revealed in the roentgenograms, which seemed to confirm the initial diagnosis of sarcoma of the soft parts. In March, 1936, the patient died in the clinic of our Institute and a primary bronchogenic carcinoma of the lung was found. The polypoid tumor of the right main bronchus gave metastases first in the thigh, then in the mediastinal lymph nodes and then in the lung, brain and other organs.

Our observations were based mostly on clinical and not on pathological material, and therefore in choosing our cases we were very careful about the multiple lesions of both lungs.

We met comparatively seldom with effusions (in pleura in only 7 cases). Therefore we cannot draw our own conclusions about the statements made in the literature that in pulmonary cancer the effusions occur comparatively early. We are not able to judge because our series of cases was small and patients with effusions arrived at the Institute at a comparatively late stage of an advanced disease.

In 4 cases of the 7 the organs of the mediastinum were displaced to the side of the lesion. In 4 cases of hemorrhagic effusions, 1 case had effusion on both sides.

In 3 cases the effusion was of a serious character. During life we were able to reveal metastases in only 28 cases, 8 cases were proved by microscopic and histologic findings and 20 cases of the series remained unproved. We must therefore presume that many metastases were not revealed at all, which was partially proved in autopsies. Metastases were found in the following parts and organs of the body:

	Cases
Mediastinum	5
Supraclavicular lymph nodes	4
Ribs	4
Spine	3
Orbit	3
Ribs and spine	1
Calvaria	1
Sternum	1
Scapula	1
Upper jaw (maxilla)	1
Pelvis	1
Axillary lymph nodes	1
Cervical lymph nodes	1
Liver and inguinal lymph nodes	1
Total	28

We can see from these figures that we did not find metastases in the mediastinum as often as other authors. Lenk mentions, for instance, that metastases in the mediastinum are found in nearly all cases of primary cancer of the lung and at an early stage of the disease. So in most cases of primary carcinoma of the lung, even if they are recognized early, the chances of operability, according to Lenk, are very small. But we may presume that cases recognized early are not so hopeless. Of importance in the diagnosis, besides metastases, are several other indirect symptoms, especially displacement of the organs of the mediastinum. These displacements were found on roentgenoscopy in 43 cases and in the roentgenogram in 8 cases (constant displacements). A high position of the diaphragm on the side of the lesion, due probably to the paralysis of the phrenic nerve compressed by metastases or to partial atelectasis of the lung, were found in 6 cases. A displacement of the trachea and of the cardiovascular shadow in the opposite direction was noted in only 2 cases.

Cavities of different size resulting in necrosis of lung tissue and bronchiectasis of large bronchi were found during life in only 12 cases, proved histologically or by microscopic findings. In 1 case in the shadow of the tumor a number of small cavities was discerned. Of course, in primary carcinoma of the lung, not all the cavities can be revealed in roentgenograms and pathologists find them more often than roentgenologists. These cavities may be of considerable size and we found them in 2 cases.

We are of the opinion that in these cavities there is nothing characteristic. They do not differ from similar cavities in tuberculosis and abscess or gangrene of the lung. Cavities are often found not in the tumor itself but in the region of a secondary atelectasis or in pneumonia, which often accompanies the cancer of the lung. But the fact must be mentioned that tuberculous and bronchiectatic cavities usually have very thin walls, and in cancer cavities no walls of this type could be observed. We were also unable to observe a distinct collapse of the cavity during cough.

Fig. 2. (No. 66181) A. L., male, aged twenty. During a period of about one year the patient experienced pain in the left chest. Dry cough. No hemoptysis. Physical examination negative. The roentgenogram taken eight months after appearance of symptoms shows a round shadow with distinct borders on the left near the heart between the second and fourth ribs. Calcification is noted in the tumor. As an echinococcus cyst was suspected, an operation was performed on March 26 and April 16, 1935. The patient died on May 6, 1935. Histopathologic findings in the tumor: fibroma calcinatum necroticans pulmonis.

We observed no calcifications either of the tumor itself or of the metastases. Such a case described by Fried remains alone in the literature. We observed calcification in only 1 case of benign tumor (Fig. 2). Similar cases are but rarely described in roentgenological literature.

We have not observed any secondary changes in the long bones such as periostitis hyperplastica described by other authors in primary carcinoma of the lung and in chronic inflammatory processes of the lungs. However, clubbing of fingers was often seen in our patients.

Concerning the "direct" roentgenologic sign of the tumor, a solitary massive shadow in the lungs, it must be kept in mind

FIG. 3. (No. 73397) G. P., male, aged fifty-four. Breathing very difficult, cough with expectoration; sometimes fever. In May, 1935, four months after the onset of symptoms the patient expectorated a piece of tissue. Histopathologic findings showed bronchogenic polypoid carcinoma. In subsequent examination of the sputum elements of neoplasm were repeatedly found. The plain roentgenogram taken on January 25, 1936, showed an indistinct outline of the right side of the diaphragm and almost total immovability. A total obstruction of the main lower bronchus is revealed in the bronchogram. The upper part of the bronchus is widened above the stenosis.

that this shadow is not always produced by the tumor itself. It is well known that cancer of the lung is often accompanied by an inflammatory process and atelectasis. These changes may be very pronounced even in small tumors and in such cases it is very difficult to obtain from the roentgenogram a clear idea concerning the outline and size of the tumor. The indication of Lenk that in atelectasis the ribs may be clearly seen on the pathologic shadow and indistinctly on the shadow of a large tumor can be applied only with great care, although it has some value.

The task of the roentgenologist is much facilitated if he can observe the growth of a tumor in roentgenograms and note its changes of size and shape.

In the differential diagnosis of carcinoma of the lung, atelectasis and secondary inflammatory processes have to be borne in mind. A displacement of the organs of the chest and of the diaphragm to the side of the lesion is an indication of atelectasis and absence of such symptoms and migration of the shadow is an indication of an inflammatory disease.

There have been long discussions regarding the shape of the solitary pathologic shadow and several classifications of this have been proposed, some based on roentgen appearance, others on pathologic anatomic findings. Some authors, as Schmoller and others, endeavor to unite these principles of classification and others even try to determine the histologic character of the neoplasm from the roentgenogram, and in this way make a prognosis.

It is evident that the surgeon, the physician, the bronchoscopist and the roentgenologist, who each has to face a different problem in carcinoma of the lung, are also in need of different classifications. Regarding the different classifications, the following problems are to be solved: (1) Is the tumor a primary one? (2) Is the tumor accompanied by secondary involvements in lungs or pleura, and what is the character of these involvements? (3) Are there any metastases and where are they situated? (4) Where is the primary location of the tumor, in the large bronchi or in the small or peripheral alveoli?

We have already given an answer to the first three questions. The last problem we can answer by reference to special cases. First case when no pathologic shadow is found in the roentgenogram, but there are symptoms of bronchiectasis. If in an elderly male are found such clinical symptoms as cough, dyspnea, a feeling of local pressure or pain in the chest, a roentgenologist may well suspect a bronchogenic carcinoma and suggest a bronchoscopy. Bronchoscopy can indicate the position and grade of stenosis as well as the state of the wall of the affected bronchus (Figs. 3 and 4). In an early stage a series of roentgenograms can be very useful (Fariñas). If no elements of neoplasm

are found in the sputum, its character can be verified by biopsy, performed at bronchoscopy. If there is no growth of the tumor tissue through the wall of the bronchus (which is not easily determined by bronchoscopy), the tumor can be extirpated or removed by electrocoagulation. If it is impossible to remove the tumor it must be treated either by internal irradiation (radon implantation) or by external deep roentgen therapy.

We must keep in mind that endobronchial tumors may be of benign character (fibromas, adenomas, etc.), and therefore be operable. An early diagnosis of these tumors is very important. Sometimes metastases occur in bronchi from various distant tumors. In our series we recognized the primary endobronchial cancer during life in 8 cases, and at postmortem in 3 cases.

In another case the roentgenologist sees in the hilum of one lung a more or less massive shadow with rays extending into the clear field around it and accompanied by symptoms of bronchostenosis. Such a shadow is very suggestive of bronchogenic carcinoma, which has destroyed the walls of the bronchi and has grown into the parenchyma of the lung.

In the differential diagnosis of carcinoma of the hilum of the lung, the major conditions to be borne in mind are actinomycosis, chronic pneumonia, lues, lymphogranulomatosis, rarely tuberculous infection and still more rarely pneumoconiosis. Sometimes the roentgen findings are similar to those in a simple peribronchitis.

In isolated cases such a shadow in the hilum can simulate an aneurysm of the aorta. Here kymography can be very helpful, as was shown in several of our cases.

The typical one-sided hilar shadow of the carcinoma with branches in the clear field of the lung is never seen in benign tumors or primary sarcoma of the lung.

With regard to cure, hilar carcinoma is the least curable type. It can be treated only with roentgen rays.

The third case is one in which the pathological shadow occupies a peripheral

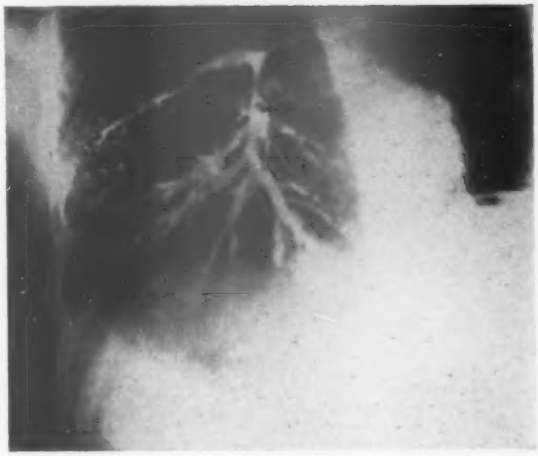

Fig. 4. (No. 73988) A. G., male, aged fifty-two. History of cough with copious expectoration, pain in the right chest; subfebrile temperature; loss of weight. The disease, with remissions and progressive aggravation of symptoms, has lasted for two years. Examination of sputum negative. A plain roentgenogram on February 11, 1936, showed a branching growth in the right lower chest. The bronchogram taken on February 17, 1936, shows a stricture of the upper part of the lower main bronchus and a small filling defect. Diagnosis was an endobronchial polypoid tumor. Bronchoscopy was tried twice without success because of the spasm of the trachea. Autopsy on May 15, 1936, revealed a pneumonic abscess, stenosis of the lower main bronchus and a fistula between the bronchus and the esophagus due to the extension of the abscess into the lymph node at the bifurcation.

position (the pneumonic type according to the classification of Overholt) (see Fig. 5). This shadow may be of varying size, shape and structure, and may or may not have sharply delineated borders. Cavities may be found inside this shadow. The roentgenological appearance may be that of pneumonia, interlobar empyema, abscess or gangrene of the lung, or tuberculous infiltration. If no metastases can be recognized either in roentgenograms or in clinical symptoms, and no elements of neoplasm are found in microscopic sputum examinations, the diagnosis is very difficult.

Puncture biopsy is not safe and positive findings cannot always be made in histologic tests. Usually bronchoscopy also gives no results. In some cases an artificial pneumothorax with thoroscopic investigation

FIG. 5. (No. 65029) R. S., male, aged seventy-three. The patient suffered from pain in the right upper chest, cough with expectoration, sometimes with a foul odor. In the sputum findings of a cancerous neoplasm. The roentgenogram was taken six months after the onset of disease. There is an oval shadow in the right lung between the second and fourth ribs (pneumonic type of the lesion).

may be tried. In lower lobe tumors pneumoperitoneum may be of some value.

Overholt considers the most important points in the diagnosis of the pneumonic form to be cough, weakness, hemoptysis, pain in the chest combined with a roentgen picture of a progressive nonfibrosing lesion.

Since peripheral types of pulmonary carcinoma seem to be the most accessible for surgery by excision of one or more lobes or removal of the total lung, the roentgen diagnosis in these cases is of great importance. If the peripheral solitary circular shadow is clearly outlined, the roentgenolgist must exclude the possibility of echinococcus cyst, sarcoma, benign tumor, metastasis and some inflammatory lesions. It is evident that a most careful analysis of roentgenograms and comparison of all clinical symptoms and laboratory findings is necessary in order to avoid a possible mistake in diagnosis. Peripheral and hilar types of carcinoma of the lung in the later course of disease may occupy the entire lobe. Transitory types as described by Lenk under the name of "Lappenrandinfiltrat" also occur.

It is evident that the difference of opinions of authors concerning which is the more common type of pulmonary cancer—the lobar or the hilar—can be explained by different periods during which the patients were observed.

In our series more common was "lobar carcinoma," which we found twice as often as the hilar type. It is our opinion that this fact as well as the small number of intralobar carcinomas (only 5 cases in our series) can be explained by the more advanced stage of disease of our patients, who applied to us comparatively very late.

In one case, a male, aged forty-six, complained of persistent cough with expectoration, and pain in the chest. There were dullness along the scapula, diminished breath sounds and limitation of the movement of the lung. No positive findings were present in the sputum. Examination of the blood

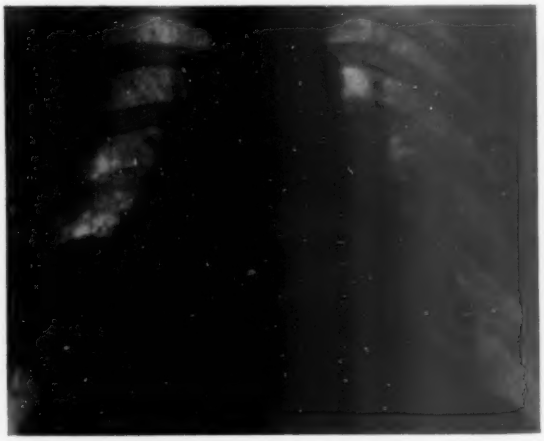

FIG. 6. (No. 72433) E. A., male, aged fifty-one. After trauma to the fingers of the left hand the patient developed the clinical picture of monoparesis, which led to a neurological diagnosis of cerebral tumor (of the right lobe). Then a slight cough appeared with expectoration. In the sputum twice were revealed findings of carcinomatous neoplastic elements. The roentgenogram taken two and a half months after the onset of symptoms shows a circular shadow in the lower right side of the chest above the diaphragm. Autopsy on December 19, 1935, revealed a primary cancer of the right lower lobe, with metastases in the right and left mediastinum, suprarenal glands, cervical lymph nodes and brain. There was a fibrous hemorrhagic effusion in the pericardium.

showed anemia, leukocytosis and lymphopenia. The roentgenogram showed an intense nonhomogeneous shadow in the right upper lobe. The lower border of the shadow was sharply delineated with an upward curvature. In deep inhalation during the roentgen examination, a displacement of the organs of the chest to the right side was observed. Autopsy showed a bronchogenic carcinoma arising from the upper bronchus with extension into the lung. Anatomic diagnosis: a cancerous pneumonia.

It is evident that in the beginning of the disease we should have in the roentgenogram a picture of hilar carcinoma with branches to the upper lobe.

In nearly two-thirds of cases of our series the tumor was in the right chest. It is a fact mentioned by practically all authors. In most cases the borders of the shadow were well outlined. In our series of lesions of the entire right upper lobe, the lower border was concave in 4 cases, convex in 5 cases and in the rest of the 26 cases appeared approximately straight.

Fig. 7. (No. 1034) A. L., male, aged twenty. The patient had been ill for one and a half years. Complains of a pain in the left chest, dyspnea and dry cough. The roentgenogram shows a massive circular shadow in the left chest. The heart shadow is a little displaced to the left. Autopsy revealed a primary sarcoma of the left lung.

Fig. 8. (No. 24952) J. D., male, aged fifty. After the grippe, patient had pain in the right chest, cough with hemorrhagic expectoration, loss of weight. Elements of malignant neoplasm were found in the sputum. The roentgenogram taken three months after the onset of the disease shows an irregular nonhomogeneous shadow below on the right medial side connected with the hilum.

A circular shadow was observed in a carcinoma in only 4 cases (Fig. 6). In the 3 cases of sarcoma (Fig. 7) and in 2 cases of fibroma circular shadows were found in the roentgenograms. In 3 cases when the right lower lobe was affected with bronchogenic carcinoma we observed a number of branches above the right side of the diaphragm. These extensions of the growth had the shape of a triangular bundle, with the apex in the hilum. A displacement of the interlobar fissure between the upper and middle lobes was present (Fig. 8). Due to the thickness of the interlobar pleura it was clearly seen in all 3 cases. In deep in-

spiration the heart made an excursion to the right.

We observed multiple nodular tumors in both lungs in only 2 cases. In 1 case of miliary carcinoma of a male, aged twenty-nine, already mentioned above, a diagnosis was made only at autopsy. In the other case with larger tumors in the middle and lower parts of both lungs, the diagnosis was made on clinical symptoms and positive laboratory findings and no autopsy was performed.

The cancerous lymphangitis which is shown in the roentgenogram, usually by a clearer outline of the lung, was found in only 2 cases of our series of primary carcinoma of both lungs verified at autopsy, and in 1 case of bilateral lymphosarcoma also proved at autopsy. In the last case elements of a sarcomatous neoplasm were found in sputum during life.

In conclusion, we may express the following opinion about the value of roentgen diagnosis in primary tumors of the lung. The roentgen examination is of considerable value and it gives to the roentgenologist the possibility of suspecting a tumor of the lung at a period when it is nearly impossible by the clinician. Therefore, the rôle of the roentgenologist in the diagnosis of pulmonary tumors is very important. To increase the number of early recognized cases of primary carcinoma of the lungs, it is necessary that the physician should keep in mind in all cases of pulmonary diseases and especially in those "indefinite" respiratory lesions the possibility of cancer. He should send the patient for roentgen examination as soon as possible.

ROENTGEN THERAPY

We should mention our experience in roentgen therapy in primary carcinoma of the lung. As stated previously the position of the radiologist in this field is not so favorable as in diagnosis. We cannot even speak of a cure of primary pulmonary carcinoma by irradiation. No radiologist has had the opportunity to describe such a case. But some authors claim that roentgen therapy may produce a palliative effect over a rather long period. Holfelder, in 1935, published a series of 10 cases of primary carcinoma of the lung which he treated with roentgen irradiation and in which he obtained good results over a period of five years. But this good effect was obtained in cases which were not proved and where the diagnosis was a doubtful one. On the contrary, in 4 proved cases of cancer he obtained practically no effect with roentgen therapy.

In his work published in 1934 Manges, after proving histologically the cases which he described in his article published in 1932, found that all 5 patients who survived the roentgen treatment a longer period had no bronchogenic cancer, as was presumed before, but benign tumors. In only one case of unclassified carcinoma the patient survived four years after the first course of roentgen therapy. All other patients with carcinoma of the lung survived only from four to twenty-seven months from the beginning of treatment. Manges emphasized the importance of an exact diagnosis and good effect of roentgen therapy in benign bronchogenic tumors. But we know some cases of primary bronchogenic carcinoma where the patients survived two or even three years without treatment of any kind. Therefore, we can evaluate the effect of irradiation only in a large series of cases. In 1927 Chandler and Potter collected 120 cases of pulmonary carcinoma. Only one-half of these cases were treated by roentgen therapy. The untreated patients lived an average of six months after diagnosis, and the treated patients eleven months. Similar data were given by Maxwell and Nicholson in 1930.

In our series, we observed nearly the same results as Leddy and Vinson in 1933. In our series of cases which were proved by histologic or microscopic examination, 44 cases were treated with roentgen therapy and the average period of survival after diagnosis was about eight months. The 21 untreated patients of the same group survived only five and a half months. In the

first group we had 6 patients who lived fifteen months to three years after the diagnosis was made. In the second untreated group, 1 patient lived over two years, and 1 patient whose disease was proved only at autopsy lived over three years from the onset of disease. The influence of roentgen therapy on clinical symptoms is beneficial; all authors agree that the pain is alleviated. In many cases the dyspnea diminishes, pain disappears or diminishes, sometimes even the cough disappears and the temperature becomes normal. The general condition of patients is often improved, they gain weight and even return to work. But there are cases in which roentgen therapy produces no results and the symptoms are even aggravated.

In our series (Table II) 56 patients were treated with roentgen therapy. In 22 cases (18 of which were proved by histologic or microscopic examination) we found a good therapeutic effect which was manifested in nearly total disappearance of clinical symptoms. In 3 cases a diminution of the pathologic shadow, due to the destruction of tumor, could be observed in the roentgenograms (Fig. 9, *A* and *B*). In other cases also we observed a decrease in the size of the shadow, but we are not sure whether or not it was caused by the destruction of the tumor mass. Perhaps it was due to diminished inflammatory reaction in the lung. We gave the full dose of intensive radiation in only 24 cases.

Twenty-five cases were treated with smaller doses, but the number of series was sometimes five. The following technique was used: constant potential apparatus of 160 to 170 kv., 0.5 mm. Cu plus 1 mm. Al filter. A dose of 30 to 70 per cent skin erythema was administered at each sitting, depending on the general condition of the patient. The affected area was irradiated from two or three or sometimes four portals. From three to eight sittings were given in each series. The patients tolerated the treatment better when it was administered with intervals of one to two days and a single dose was not over 50 to 60 per cent of a skin erythema. We did not use the fractional protracted method of Coutard. No radium or surgical treatment was employed.

The observations of Herrnheiser about the greater efficiency of the protracted method of roentgen therapy which he applied in 16 cases may be correct. But this method, as well as the endobronchial implantation of radon seeds, seems as yet to have no important advantages.

Contraindications for the use of roentgen therapy are poor general condition and fever. Anemia is also usually a contraindication for roentgen therapy. If the patients suffer from a secondary pneumonia, great care is necessary in administration of roent-

TABLE II

ROENTGEN THERAPY OF CANCER OF THE LUNG

A. Dosage

Roentgen therapy of small intensity (1–2 series of small doses)	Roentgen therapy of medium intensity (2–5 series of medium doses)	Roentgen therapy of strong intensity (2–3 series)	Total
7	25	24	56*

B. Results

Temporary improvement	No change	Worse	Indefinite results
22	16	2	16

* Of this total number 44 cases were verified by histologic and microscopic findings.

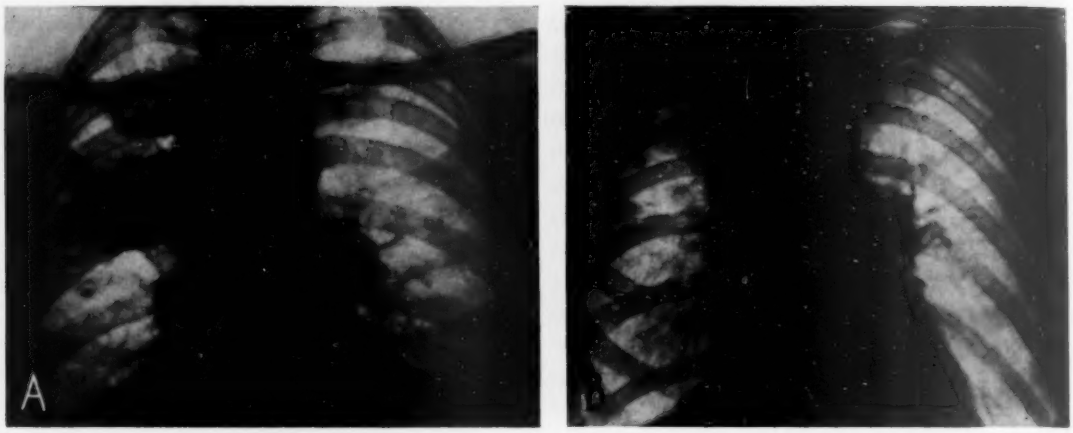

FIG. 9. (No. 57092) I. G., male, aged fifty-three. After an attack of grippe in February, 1933, the patient had a periodic cough with expectoration, sometimes hemorrhagic, pain in the chest, and fever sometimes as high as 39° C. During a period of over three years elements of carcinomatous neoplasm were always found in the sputum and tubercle bacilli were never found. *A*, roentgenogram on January 21, 1934, shows a shadow near the right hilum. On the borders radial branches to the upper part of the lung are seen. Within the tumor there are small multiple cavities. *B*, roentgenogram taken on June 25, 1935, after five series of roentgen therapy shows a disappearance of the original shadow of the tumor. A thickening of the hilum is now seen and a paravertebral shadow on the right side. There is a partial atelectasis of the right upper lobe. The patient died in a month from a hemorrhage.

gen therapy. Sometimes after irradiation we observed fever, more severe cough with expectoration, findings of neoplastic elements in sputum, although before the treatment those symptoms were not so evident.

In one case, a male, aged sixty-two, where cancer of the lung was suspected from clinical symptoms and roentgen findings the tubercle bacillus which could not be discovered before was found in the sputum after one series of roentgen therapy.

In our series of cases with total bronchostenosis roentgen therapy was of little use. In treatment of metastasis we seldom had a good effect.

If in most cases cancer of the lung could be recognized five or six months earlier, roentgen therapy would give better results. As a rule, each case must be treated individually; localization of the lesion and clinical symptoms must always be considered.

We agree with Saupe who has published the results of roentgen therapy in a series of 200 cases of carcinoma of the lung. He believes that, notwithstanding the poor results of this method of treatment, it should be applied in pulmonary cancer. Of course the technique will be improved, but the most important thing is early diagnosis. Roentgen therapy should be applied as early as possible when the patients are still in good general condition. In operable cases of endobronchial carcinoma better results can be obtained when the surgical treatment is combined with irradiation.

REFERENCES

1. ABRAMOVITCH and RAVICH. Primary tumors of the lungs. *J. klinitsch. roentgenol.*, Vol. 2, pp. 125–143.
2. AISENBERG, A. A. Primary Cancer of the Lungs. 1936.
3. ALTHAUSEN and NOSSALEVICH. Microscopic diagnosis of malignant tumors in the tests of sputum, pus, fluid, etc. *Vratch. Delo*, Nos. 2 and 3, 1933.
4. ASSMANN. Erfahrungen über die Röntgenuntersuchung der Lungen. 1914.
5. ASSMANN. Röntgendiagnostik der inneren Krankheiten. 1924.
6. BARJON. Radiodiagnostic des affections pleuropulmonaires. 1916, pp. 151–162.
7. BEAL, J. R., and GRAY, E. D. Case of pulmonary neoplasm of the cavernous type. *Brit. J. Radiol.*, 1928, *1*, 151–155.
8. BUTLER, P. F., and RITVO, M. Primary carci-

noma of the lung; diagnosis and treatment with x-ray. *New England J. Med.*, 1932, *207*, 435–443.

9. Chandler, F. G., and Potter, C. T. Investigation into result of x-ray treatment of primary malignant intrathoracic tumours. *Lancet*, 1927, *2*, 596–598.
10. Deist. Diagnose der Lungentumoren. *Klin. Wchnschr.*, 1924, No. 48.
11. Edling, L. Ein sehr seltener Fall gutartigen Lungentumors. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1917–1918, *25*, 25–28.
12. Farrell, J. T., Jr. Diagnosis of bronchial carcinoma. *Radiology*, 1936, *26*, 261–269.
13. Fariñas, P. L. Serial bronchography in early diagnosis of bronchial carcinoma. Am. J. Roentgenol. & Rad. Therapy, 1934, *32*, 757–762.
14. Fried, B. M. Bronchogenic cancer; treatment with roentgen rays. *Am. J. Cancer*, 1934, *20*, 791–806.
15. Geschickter, C. F., and Denison, R. Primary carcinoma of the lung. *Am. J. Cancer*, 1934, *22*, 854–877.
16. Greer, E. A. Primary carcinoma of the lung, with report of case. Year Book of Radiology. Year Book Publishing Co., Chicago, 1932, pp. 515–518.
17. Murdoch, J. Diagnostic radiologique des tumeurs pulmonaires. *Cancer, Bruxelles*, 1931, *8*, 150–160.
18. Herrnheiser, G. Die Strahlenempfindlichkeit des Bronchialkarzinoms. *Strahlentherapie*, 1932, *45*, 269–280.
19. Herrnheiser, G. Weitere Erfahrungen mit der Röntgenbehandlung maligner Bronchus- und Lungengeschwülste. *Strahlentherapie*, 1935, *52*, 425–459.
20. Holfelder, H. Die Prognose des Lungenkrebses bei Röntgenbestrahlung. *Strahlentherapie*, 1935, *54*, 438–458.
21. Katzmann, A., and Kusmenko, G. Roentgen diagnosis of primary carcinoma of the lung. *Vest. roentgenol.*, 1932, *10*, 214–228.
22. Kudriavtzewa, N. Roentgen diagnosis of cancer of the lung. *Novaya chir.*, Vol. 6, pp. 433–472.
23. Leddy, E. T., and Vinson, P. P. Roentgen treatment of bronchiogenic carcinoma. Am. J. Roentgenol. & Rad. Therapy, 1933, *30*, 92–94.
24. Lenk, R. Die Röntgendiagnostik der intrathorakalen Tumoren und ihre Differentialdiagnose. J. Springer, Berlin, 1929.
25. Levy Dorn. Roentgen diagnosis of tumors of the lung. *Vest. roentgenol.*, 1922, *1*, 383–389.
26. Lucas, E., and Pollack, H. Beitrag zur Diagnostik der Lymphangitis carcinomatosa in der Lunge. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1930, *41*, 865–872.
27. Lüdin, M. Der solitäre, umschriebene, rundliche Schatten im Lungenröntgenogramm. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, *34*, 899–904.
28. Manges, W. F. Primary carcinoma of the lung. Am. J. Roentgenol. & Rad. Therapy, 1932, *27*, 858–869.
29. Manges, W. F. Analysis of a group of primary new growths of the lungs, treated with deep x-ray therapy. *Radiology*, 1934, *22*, 423–425.
30. Milhit, J., Huguenin, R., and Albot, G. Difficultés diagnostiques du cancer primitif du poumon. *Bull. de l'Assoc. franç. p. l'étude du cancer*, 1930, *19*, 263–269.
31. Otten, M. Zur Röntgen-Diagnostik der primären Lungencarcinome. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1905–1906, *9*, 369–376.
32. Otten, M. Die Röntgendiagnose der Lungengeschwülste. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1910, *15*, 1–31.
33. Overholt, R. H. Primary carcinoma of the lung; early diagnosis and treatment by pneumonectomy. *New England J. Med.*, 1936, *214*, 93–100.
34. Pancoast, H. K., Pendergrass, E. P., and Tucker, G. Primary bronchogenic carcinoma of the lungs. Am. J. Roentgenol. & Rad. Therapy, 1932, *27*, 357–362.
35. Peet, E. W. Primary pulmonary carcinoma. Year Book of Radiology. Year Book Publishing Co., Chicago, 1932, pp. 518–519.
36. Popper, L. Ueber Bronchuskarzinome. *Ztschr. f. klin. Med.*, 1934, *126*, 689–700.
37. Saupe, E. Erfahrungen mit der Röntgenbehandlung bei 200 Patienten mit Lungenkrebs. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1936, *53*, 549–560.
38. Schmoller, G. Die Grundlage der Diagnose der Lungentumoren. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1923–1924, *31*, 399–417.
39. Steiner, P. E., and Francis, B. F. Primary apical lung carcinoma. *Am. J. Cancer*, 1934, *22*, 776–785.
40. Thomas, G. F., and Farmer, H. L. Diagnosis of primary intrathoracic neoplasms. Am. J. Roentgenol. & Rad. Therapy, 1924, *11*, 391–405.
41. Tyler, A. E. Treatment of bronchial carcinoma by electrocoagulation, radium implants and high voltage x-rays. Year Book of Radiology. Year Book Publishing Co., Chicago, 1932, p. 522.

PROGRESSIVE HEPATOLENTICULAR DEGENERATION WITH ELECTRO- AND PNEUMO-ENCEPHALOGRAMS*

REPORT OF CASE

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SINCE the original description of progressive hepatolenticular degeneration given by Wilson[7] in 1912, numerous additions have been made to the literature and many case studies presented, but no reports have been found of electro-encephalographic studies and there have been only a few published pneumo-encephalograms. In 1936 Goodhart, Balser and Bieber[2] reported 3 cases with pneumo-encephalograms and mentioned that a few isolated cases were scattered throughout the literature. It has therefore seemed worth while to present the following clinical observations, roentgenograms, and reproductions of brain potentials.

REPORT OF A CASE

Clinical History. A. C., male, white, aged twenty-five, was admitted to the Boston Psychopathic Hospital on December 29, 1938, with the complaints of generalized weakness and slowness in movement.

The family is of Italian stock and low in intellect. The mother is temperamental and emotionally labile. The patient is the fourth of ten siblings. One died at the age of seventeen of "meningitis necessitating operation" which followed a blow on the head and another in infancy of "pneumonia." No other member of the family has presented a picture similar to that of the patient.

Birth and early development were normal. As a small child he had "poisoned glands" in the right side of his neck. In high school he was considered a "good boy" and interested in football. He was graduated at eighteen, the brightest of his brothers and sisters. At twenty-one he was struck on the head by a falling tree; immediate unconsciousness lasted two minutes. He remained in bed for three days and did not return to work for two weeks. During this time he complained of headache but did not vomit. One year later he visited a general hospital, complaining that since the age of eighteen he had suffered aches in the head, eyes, stomach, and legs which were associated with a "dopey feeling" and loss of interest and had resulted in withdrawal from his friends and previous activities. He also mentioned nocturia five to six times a night, loss of weight, and increasing constipation. A report from this hospital lists only the following positive signs: "mask-facies, slowed cerebration, persistent mild leukopenia (4,400), occasional granular and hyaline casts, and a slightly elevated total protein in the spinal fluid." A diagnosis was made of "?post-encephalitic parkinsonism." The patient was started on stramonium, hyoscine, and mg. x of benzedrine sulphate per day, which were discontinued because of insomnia and "upset stomach."

At the age of twenty-three he developed increasing slowness of all movements and occasional falling. He "seemed strong but couldn't use his muscles." Finally his mother brought him to the Boston Psychopathic Hospital, complaining that he was becoming increasingly "cranky all the time like anyone sick . . . gets mad and wants to jump out of the window."

Physical Examination. A poorly nourished asthenic man with a mask-like facies, the mouth fixed in a continual silly grin (Fig. 1). All muscles were weak. There was generalized slowing of voluntary movements so that he required assistance in dressing, feeding, and walking. He showed festination, decreased alternate motion rate of tongue, fingers, and arms, cog-wheel rigidity of arms, and minimal movement of forehead on upward gaze. Pupils were round and equal, slightly sluggish to light but less so on accommodation. With the slit lamp typical Kayser-Fleischer rings were seen at the periphery of both corneas in the region of Descemet's membrane; sunflower cataracts both lenses; vision 80 per cent bilaterally. While the left side of the face was smoother than the right, there was no difference in movement. The tongue protruded to the left with slight fine

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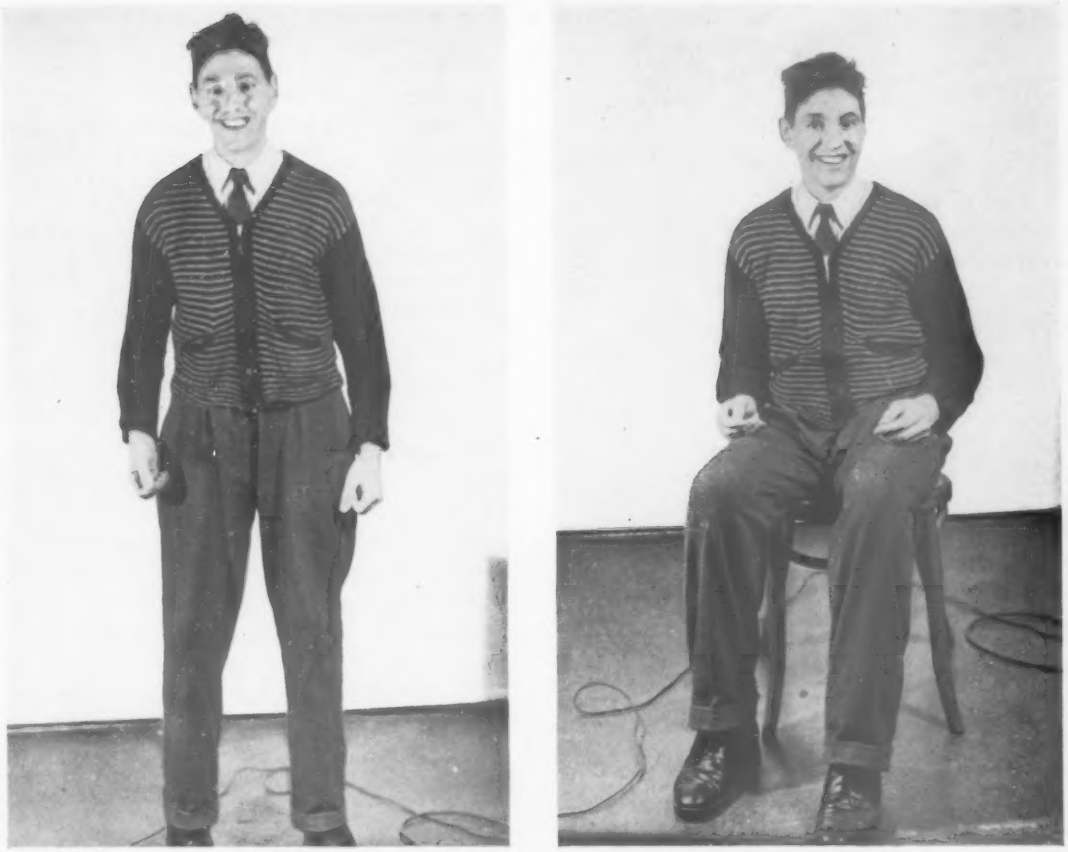

Fig. 1. Patient with progressive hepatolenticular degeneration showing fixed grin, pill-rolling position of hands and wide base.

tremor. The hands were usually held in a pill-rolling position, and a classical pill-rolling tremor infrequently appeared both at rest and on voluntary movement. The speech was slow, nasal, and tremulous; consonants, especially labials, were articulated with difficulty so that he usually resorted to sign language. Saliva collected in his mouth but he did not drool. He also showed moderate dermatographia and cold moist hands and feet. The upper extremity deep tendon reflexes were bilaterally very brisk; the knee and tendo achillis jerks were more active on the right than on the left. There were bilaterally Hoffmann's sign and exaggerated finger jerks. Sign of Babinski on the right. There was a right parietal linear scar. Large brownish macules of a type not seen in liver disease (probably a dermatitis medicamentosa as the result of potassium permanganate and ferric chloride treatment for poison ivy) were found on the skin of legs and feet. The heart, lung, and abdominal findings were within normal limits. The size of the liver was not demonstrably increased or decreased. Blood pressure, 120/80; temperature 98° F; pulse 84; respiration 20.

Psychiatric Examination. The patient was well oriented and alert. His appetite was good and his sleep regular. Speech and thought were relevant and coherent. Although there were occasional flashes of irritability, the mood was usually placid and mildly euphoric. No hallucinations or delusions were elicited, but there was a tendency to misinterpret the speech and and actions of others as being hostile or discriminating. Memory was intact; insight and judgment were good. He was thought to be of average intelligence and showed no sign of deterioration. He complained chiefly of "stiffness," easy fatigability, and the accumulation of saliva. Nocturia still occurred 5 to 6 times nightly with occasional nocturnal enuresis.

Laboratory Data. Hemoglobin 12.8 mg. per 100 cc.; white blood cells 4,700 and 7,600; red blood cells, 4,400,000; blood smear normal.

Urine showed trace of albumin, sp. gr. 1.010 to 1.022; blood Wassermann and Hinton reactions negative; fasting blood sugar 84 and 96 mg. per 100 cc.; two glucose tolerance tests within normal limits, the level rising to 216 mg. per 100 cc. after one hour and dropping to 76 mg. per

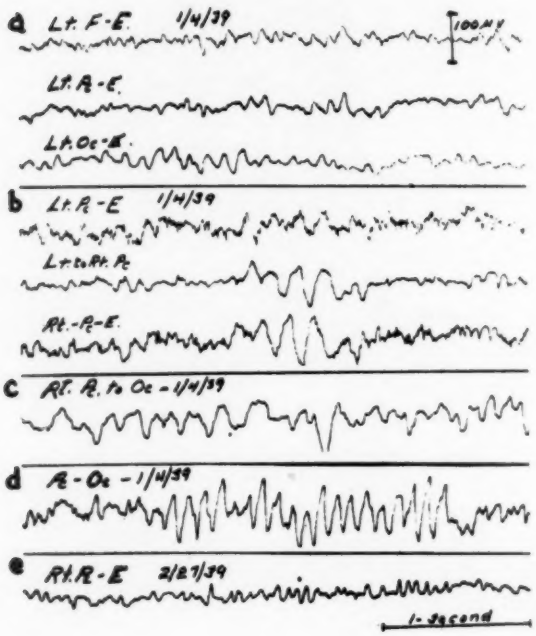

FIG. 2. Sample electro-encephalographic tracings showing the varied nature of the abnormalities (see text for description).

100 cc. after three hours; galactose tolerance test showed a 1 plus galactose reaction in the one hour specimen only; icteric index 5; Takata-Ara test faintly positive. Spinal fluid initial pressure 90, final pressure 70 after the removal of 10 cc., total protein 62 mg. per 100 cc., globulin 1 plus, cell count 0, gold sol 0011000000, Wassermann and Hinton reactions negative. Roentgenograms of the skull showed asymmetry with flattening of the left parietal bone in the region of the eminence, areas of increased and decreased density (probably due to faulty bone metabolism), but no pressure signs or evidence of fracture.

Electro-encephalogram. Outstanding in the electro-encephalographic record was the fact that most of the time the potentials from all of the leads were normal. When abnormal potentials did occur, they varied in nature (Fig. 2).

a. Simultaneous tracings from the left frontal, precentral, and occipital regions showing the more normal parts of the record.
b. Left and right precentral records illustrating an outburst of 6 per second; high voltage potentials showing greater amplitude from the right precentral. This difference in the simultaneous tracings of the two precentral areas is shown in the bipolar left to right precentral lead.
c. A run of abnormally slow 4.5 to 5 per second potentials.
d. A sudden outburst of high voltage 9 per second potentials from a bipolar precentral to occipital lead.
e. A run of rapid frequencies about 15 per second from the right precentral region.

Pneumo-encephalogram. By means of the automatic simultaneous replacement apparatus devised by von Storch[6] 220 cc. of spinal fluid was removed and 240 cc. of air was injected into the spinal subarachnoid space. Films were taken with the head erect. The right lateral ventricle filled poorly. The left lateral ventricle filled well except for the occipital horn; it has essentially normal contours and is not significantly enlarged (Fig. 3). The third ventricle is in its

FIG. 3. Pneumo-encephalogram showing an increased amount of air in the cerebral sulci especially on the right. The third and lateral ventricles are within normal limits.

normal position and is not enlarged beyond the upper limits of the normal, although the width (8 mm.) is slightly greater than that of the average. The fourth ventricle is normal in shape, position, and size (Fig. 4). There is an increase in the amount of air in all of the cerebral sulci but especially in those on the right.

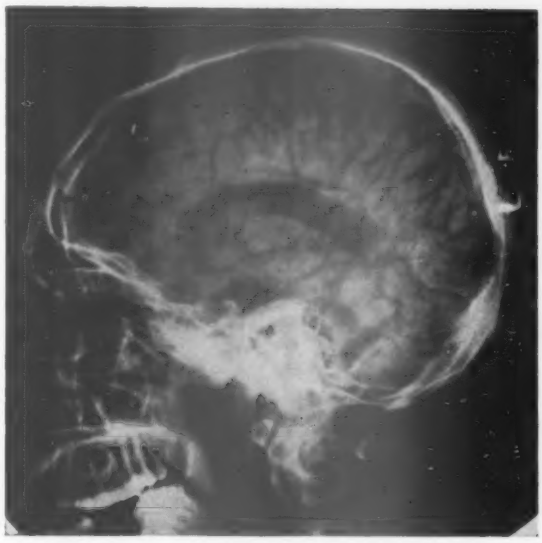

FIG. 4. Pneumo-encephalogram showing an increased amount of air in the cerebral sulci. The fourth ventricle is normal.

COMMENT

Although trauma has been described by Halpern[4] as a cause of "conditions resembling Wilson's disease," there is sufficient evidence in this case that the pathological process in the central nervous system had its onset before the head injury. Most workers now consider the differentiation between Wilson's disease and Westphal's pseudosclerosis artificial and unnecessary since the two syndromes apparently belong to the same general group of motility disorders. Clinically, the picture presented here conforms better to that of Westphal's cases, which showed Kayser-Fleischer rings and pyramidal tract signs while Wilson's did not. Reports of pathological examinations indicate[3] that in Westphal's pseudosclerosis the cortical atrophy is more marked than the wasting of the basal ganglia while in a true Wilson's disease the cortical convolutions are macroscopically normal. The pneumo-encephalograms in this case show preponderance of cortical change so that in this respect, too, it falls into the Westphal group. These observations also fit with Goodhart's report of air injections in 3 cases of Wilson's disease for he mentioned that all showed "dilation of the anterior portion of the lateral ventricles" while only one "advanced" case showed "moderate" cortical atrophy. Although there have been no reported electro-encephalograms in cases of progressive hepatolenticular degeneration, essentially normal brain potentials have been found in similar disorders of voluntary movement such as paralysis agitans, chorea, and athetosis.[1,5] It is not surprising, however, to find abnormalities in the case presented here since there is rather marked disturbance of the cortical substance.

REFERENCES

1. BERGER, H. Ueber das Elektrenkephalogramm des Menschen. *Arch. f. Psychiat.*, 1931, *94*, 16–60.
2. GOODHART, S. P., BALSER, B. H., and BIEBER, I. Encephalographic studies in cases of extrapyramidal disease. *Arch. Neurol. & Psychiat.*, 1936, *35*, 240–252.
3. GRINKER, R. R. Neurology. Charles C Thomas, Springfield, Ill., 1934.
4. HALPERN, L. Traumatic origin of conditions resembling Wilson's disease. *Deutsche Ztschr. f. Nervenh.*, 1932, *127*, 229–247.
5. JASPER, H. H. Cortical excitatory state and variability in human brain rhythms. *Science*, 1936, *83*, 259–260.
6. VON STORCH T J C. On the technique of encephalography, with special reference to use of apparatus. AM. J. ROENTGENOL. & RAD. THERAPY, 1936, *35*, 78–92.
7. WILSON, S. A. K. Progressive lenticular degeneration; a familial nervous disease associated with cirrhosis of the liver. *Brain*, 1911–1912, *34*, 295–509.

THE ROENTGENOLOGIC DIAGNOSIS OF PERIDUODENAL AND EXTRADUODENAL LESIONS*

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THIS study was undertaken in an effort to establish differential diagnostic criteria for the various pathological lesions which have been reviewed. It has been impossible to determine infallible criteria for the diagnosis of any of these processes, but I believe that we would profit by more frequent consideration of such lesions when bizarre deformities exist in the gastric antrum and the duodenum.

Surgical or postmortem proof of the precise nature of the pathological process was established in all cases studied. Included in the material were 10 instances of carcinoma of the head of the pancreas, only 3 of which presented no evidence of metastases. One case was found in which carcinoma was present only in the tail of the pancreas, but in 2 others the entire pancreas was involved. There was one pancreatic cyst, and one patient had chronic pancreatitis, while 2 had acute pancreatitis. Three cases of carcinoma of the gallbladder were included, in one of which there was an associated generalized carcinomatosis. Extensive perigastric adhesions were found in one patient, an inflammatory omental mass secondary to perforation of the gallbladder in another. Periduodenitis and pancreatitis were a consequence of perforating ulcer of the duodenum in 2 instances, while in one no definite evidence of ulcer was found. There was one case of undifferentiated sarcoma of the mesentery, with pressure on the distal segment of the stomach and the first and second segments of the duodenum. Epigastric lymph nodes were enlarged due to metastases from embryoma of the testis in one patient, because of involvment by lymphosarcoma in 2, and due to undifferentiated sarcoma in another. A wide variety of lesions has thus been included, all of which produced deformity of the gastric antrum, the duodenum, or both, due to pressure upon or to invasion of these structures.

The deformity of contiguous structures produced by carcinoma of any pancreatic segment is necessarily dependent upon the extent of the tumefaction. Most observers have noted pressure effects upon both the stomach and the duodenum in patients with carcinoma of the head and body of the pancreas. The stomach is often displaced up and forward, and there is likely to be a filling defect of the greater curvature. The medial concavity of the second portion of the duodenum is likely to be increased. Frostberg described a characteristic duodenal deformity, consisting of two superimposed depressions at the concave medial margin of the descending duodenum, with a rounded eminence at the point of junction of the two depressions, in 3 cases of pancreatic lesion. One of his patients had carcinoma of the head of the pancreas, one had carcinoma of the papilla of Vater, and one, pancreatitis.

The classical roentgen finding in carcinoma of the head of the pancreas is an increase in the left concavity of the duodenum. This widening of the "C" curve is a result of rotation of the pylorus upward and to the left, displacement of the first portion of the duodenum upward, of the second portion to the right, and of the third portion downward. Any segment of the duodenum may be compressed or invaded, and the walls of the stomach may also be compromised. It must be borne in mind that frequently, at the time of initial observation, there is also invasion of other contiguous structures, with consequent modification of the findings. An additional and, I believe, previously unreported diagnostic

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point of interest is rotation of a duodenal diverticulum, if one be present. The rotation of a diverticulum of the second portion of the duodenum found in 3 cases among the series studied was upward and to the right, and the inferomedial surface of the diverticulum was flattened. The latter finding can of course be observed only when a diverticulum is present and the other diagnostic points are noted in by no means all instances of carcinoma of the head of the pancreas. The rotation and distortion of a diverticulum is well illustrated in Figure 1, for which I am indebted to Dr. J. Richards Aurelius of St. Paul, Minnesota. This and the other characteristic alterations produced in both stomach and duodenum found in the patient were due to the presence of a carcinoma of the head of the pancreas.

In only 3 of the 10 proved cases available for study was the cancer of the head of the pancreas limited to the site of origin. These were presumably instances of early recognition of the neoplasm. All exhibited extrinsic pressure on the gastric antrum, and in 2 the base of the duodenal cap was also narrowed; in one instance the entire duodenum was compromised. In one patient (Fig. 2) the stenosis was limited to the second and third portions. Although the left concavity of the duodenum was increased in 3 patients, no such change was found in one but the antral deformity was here well visualized.

Fig. 1. Distortion of duodenal diverticulum as well as duodenum and gastric antrum in carcinoma of head of pancreas.

Fig. 2. Duodenal stenosis in pancreatic carcinoma.

In 7 patients who had primary carcinoma of the head of the pancreas there was extension of the growth to contiguous structures. Three had metastasis to the liver, 2 had invasion of the biliary duct system, one, invasion of the stomach wall, and one, carcinomatosis. In all cases with invasion of the liver, the antrum was narrowed in a manner similar to that seen in the uncomplicated group. In one patient who had bile duct invasion, the gallbladder was distended, and the first portion of the duode-

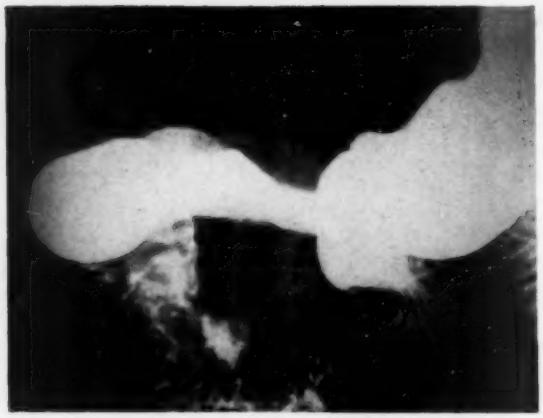

FIG. 3. Displacement of descending duodenum to left in carcinoma of head of pancreas with metastases to liver.

num was displaced to the left, the entire duodenum being slightly dilated. In the other instance of duct invasion the only demonstrable change was spasticity of the gastric antrum. Bizarre deformity of the stomach and a fair duplication of the deformity described by Frostberg, without narrowing of the duodenal lumen, and with displacement of the descending duodenum to the left were found (Fig. 3) in one patient who had carcinoma of the head of the pancreas, with liver metastases.

Our files include only one proved instance of carcinoma of the tail of the pancreas, and this patient presented no significant changes in the stomach or duodenum. We have twice seen changes produced by carcinoma of the entire pancreas. Both of these exhibited evidence of extrinsic pressure on the duodenum; in one, the concavity of the second portion was widened, in the other, narrowed.

The most bizarre findings may be produced by pancreatic cysts, in the presence of which large filling defects are commonly found in the stomach and duodenum, with associated marked displacement of the colon. In one case (Fig. 4) we found the stomach displaced to the left and downward, with an elongated, ribbon-like appearance. In addition, the pressure was so great that there was a marked deformity in the pyelograms, which presented the appearance of bilateral polycystic kidneys. The entire roentgen picture was first thought due to polycystic kidneys, but exploration of the left kidney failed to reveal such a condition. The abdomen was then opened, and a huge cyst was found in the gastroduodenal mesentery, which contained one gallon of fluid with all the characteristics of pancreatic secretion.

The changes produced by pancreatitis are also extremely varied but may be similar to those of carcinoma of the head of the pancreas. Duodenal dilatation or narrowing may occur, but the former has been reported as a more frequent finding, and is due to atony. The presence of an extrinsic gastric filling defect has been noted in pancreatitis by several observers. I have seen a number of patients who presented a syndrome of gaseous dyspepsia and epigastric pain, associated with roentgenologically demonstrable narrowing and irritability in the duodenum and pyloric antrum. These patients have been consid-

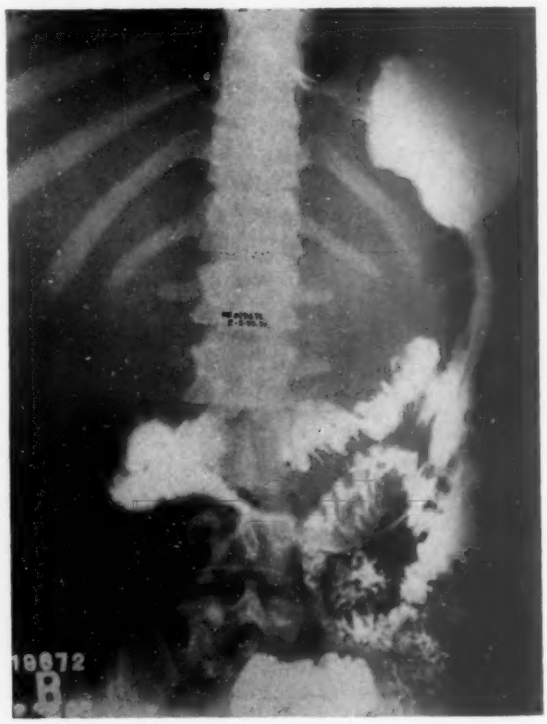

FIG. 4. Distortion of stomach and duodenum in pancreatic cyst.

ered clinically and roentgenologically to have had pancreatitis; all have recovered, and none have been explored surgically. Negative roentgen findings were obtained in several patients who had surgically demonstrable acute pancreatitis. In another instance of acute hemorrhagic pancreatitis (Fig. 5) the barium meal was almost completely obstructed at the junction of the first and second portions of the duodenum. The second and third portions were considerably narrowed, and the first portion was dilated.

It would be most difficult to demonstrate any roentgenologic changes in the majority of instances in which the surgeon makes the diagnosis of chronic pancreatitis, due to the absence of tumefaction, and as a consequence roentgen diagnosis is seldom made. In one case of chronic pancreatitis the first portion of the duodenum was rotated and displaced medially by an enlarged gallbladder, and the second portion of the duodenum was narrowed.

The roentgenologic findings in neoplasm of the gallbladder have received little consideration in the literature. Butler and Ritvo reported that deformity of the colon, stomach and duodenum might result from enlargement of the gallbladder. Eisler noted that indentation of the bulb, the upper knee, or pars descendens duodeni might occur. In 3 proved instances of carcinoma primary in the gallbladder and biliary tract I have noted stenosis of the second and third portions of the duodenum. In 2 of these cases there was associated a rather marked degree of spasm of the gastric antrum, and in 2, the cap was narrowed and displaced by an enlarged gallbladder. In one, the stomach and duodenum were rather markedly displaced anteriorly, and the deformity, illustrated in Figure 6, was similar to that produced by retroperitoneal tumors. In this case a marked degree of obstruction was found.

Extensive inflammatory perigastric or

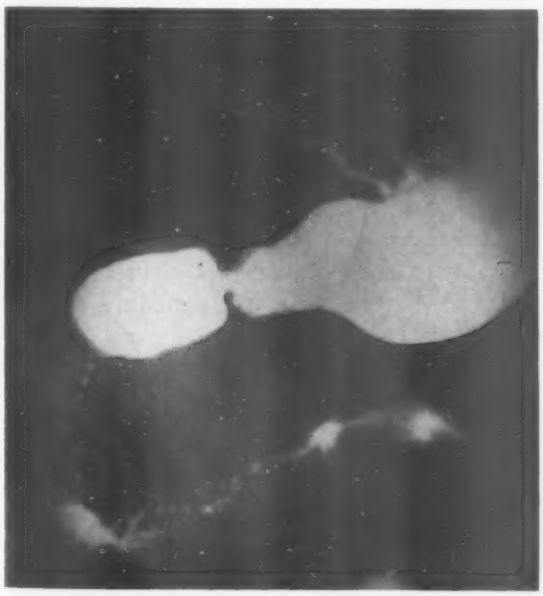

FIG. 5. Obstruction of duodenum due to acute hemorrhagic pancreatitis.

FIG. 6. Carcinoma of gallbladder and biliary tract distorts and displaces stomach and duodenum.

FIG. 7. Changes due to inflammatory omental mass.

periduodenal adhesions may produce decided roentgenologically demonstrable changes in the stomach or duodenum. In a patient with perigastric adhesions a large extrinsic filling defect was found to involve the entire greater curvature, with marked narrowing of the lumen and displacement of the stomach upward and to the right. The duodenum was narrowed and the duodenojejunal junction depressed. In another patient (Fig. 7) there was an inflammatory omental mass secondary to acute calculous cholecystitis, associated with extensive adhesions. Here there was marked narrowing of the duodenum and of the distal end of the stomach; the transverse colon and hepatic flexure were displaced downward, and presented an irregular outline. A thick sheet of fibrous adhesions surrounded the descending duodenum of another patient and gave rise to the roentgen findings seen in Figure 8. The surgeon felt that the patient might have had a previous attack of pancreatitis which gave rise to the changes which were demonstrated. This patient had had intermittent attacks of upper abdominal pain for fifteen years. In another patient,

FIG. 8. Extensive periduodenal adhesions.

FIG. 9. Perforating ulcer of descending duodenum.

a large perforating ulcer of the descending duodenum was associated with periduodenitis, and a solid mass of adhesions involved the round ligament of the liver, the anterior wall of the lower end of the stomach and duodenum, the liver and gallbladder. Marked narrowing was noted in the entire duodenum. A large ulcer crater was present on the medial margin of the descending duodenum (Fig. 9), the appearance of which resembled that found in other cases in which a duodenal diverticulum was compressed by a pancreatic neoplasm. Three other patients have subsequently been examined who had duodenal ulcer with perforation posteromedially, with associated pancreatitis and duodenitis.

Two were in the second portion, and one in the distal portion of the first segment.

Epigastric lymph node or mesenteric tumors may produce deformity of the outline of the stomach and duodenum. In a patient who had epigastric node metastasis from embryoma of the testis the lower segments of the stomach were elongated and narrowed, the upper portion displaced upward. The duodenum and jejunum were displaced to the right, and the medial concavity of the duodenum was accentuated. In a patient who had retroperitoneal sarcoma (Fig. 10) the stomach was displaced upward and to the right, the jejunum downward and to the right and the normal curve of the duodenum was markedly diminished. A bizarre narrowing of the lower end of the stomach, associated with distortion of the duodenum, resulted from a sarcoma of the mesentery. Retroperitoneal lymphoma produced obvious manifestations of extrinsic pressure on the stomach, but the duodenum was relatively intact. Another case of lymphosarcoma of mesenteric and retroperitoneal nodes was associated with extensive adhesions about the duodenum and distal end of the stomach, without sarcomatous infiltration. There was slight diffuse narrowing of the affected regions of both stomach and duodenum. In a case of undifferentiated sarcoma in the epigastric nodes, distortion and displacement of the stomach, duodenum and transverse colon, with complete obstruction of the second portion of the duodenum occurred.

I believe that the recognition of periduodenal and extraduodenal lesions is of great importance, and that they should be kept in mind more often than they are. Though sometimes present when both stomach and duodenum are normal in appearance, they often produce extensive changes in the outline of both structures.

It is obvious that, although one can often

Fig. 10. Gastric and duodenal distortion due to sarcoma of the mesentery.

be certain that deformity of the duodenum or of the stomach is a result of extrinsic pressure, the differential diagnosis of such lesions is practically impossible. Different pathological processes may produce similar manifestations, and the same type of lesion may be responsible for varied deformities. The only criterion which I have thus far found to be absolutely reliable is the compression and rotation of a duodenal diverticulum by carcinoma of the head of the pancreas.

Further study of larger groups of cases may lead to more accurate differentiation of these most interesting and important lesions, whose successful surgical attack depends so vitally upon early diagnosis.

REFERENCES

1. Butler, P. F., and Ritvo, M. Extra-bowel pathology. Am. J. Roentgenol. & Rad. Therapy, 1931, *25*, 474–481.
2. Eisler, F. Die Röntgendiagnose der Gallenblasen- und Pankreastumoren. *Wien. klin. Wchnschr.*, 1931, *44*, 1441–1443.
3. Frostberg, N. A characteristic duodenal deformity in cases of different kinds of perivaterial enlargement of the pancreas. *Acta radiol.*, 1938, *19*, 164–173.

FIG. 7. Changes due to inflammatory omental mass.

periduodenal adhesions may produce decided roentgenologically demonstrable changes in the stomach or duodenum. In a patient with perigastric adhesions a large extrinsic filling defect was found to involve the entire greater curvature, with marked narrowing of the lumen and displacement of the stomach upward and to the right. The duodenum was narrowed and the duodenojejunal junction depressed. In another patient (Fig. 7) there was an inflammatory omental mass secondary to acute calculous cholecystitis, associated with extensive adhesions. Here there was marked narrowing of the duodenum and of the distal end of the stomach; the transverse colon and hepatic flexure were displaced downward, and presented an irregular outline. A thick sheet of fibrous adhesions surrounded the descending duodenum of another patient and gave rise to the roentgen findings seen in Figure 8. The surgeon felt that the patient might have had a previous attack of pancreatitis which gave rise to the changes which were demonstrated. This patient had had intermittent attacks of upper abdominal pain for fifteen years. In another patient,

FIG. 8. Extensive periduodenal adhesions.

FIG. 9. Perforating ulcer of descending duodenum.

a large perforating ulcer of the descending duodenum was associated with periduodenitis, and a solid mass of adhesions involved the round ligament of the liver, the anterior wall of the lower end of the stomach and duodenum, the liver and gallbladder. Marked narrowing was noted in the entire duodenum. A large ulcer crater was present on the medial margin of the descending duodenum (Fig. 9), the appearance of which resembled that found in other cases in which a duodenal diverticulum was compressed by a pancreatic neoplasm. Three other patients have subsequently been examined who had duodenal ulcer with perforation posteromedially, with associated pancreatitis and duodenitis.

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REFERENCES

1. BUTLER, P. F., and RITVO, M. Extra-bowel pathology. AM. J. ROENTGENOL. & RAD. THERAPY, 1931, *25*, 474–481.
2. EISLER, F. Die Röntgendiagnose der Gallenblasen- und Pankreastumoren. *Wien. klin. Wchnschr.*, 1931, *44*, 1441–1443.
3. FROSTBERG, N. A characteristic duodenal deformity in cases of different kinds of perivaterial enlargement of the pancreas. *Acta radiol.*, 1938, *19*, 164–173.

A ROENTGEN-RAY AID IN THE DIAGNOSIS OF ACUTE PORTAL THROMBOSIS (PYLEPHLEBITIS)*

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PROBABLY because of the numerous communications between the portal veins and the superior and inferior caval systems which collate the circulation, and in the absence of specific symptoms, the diagnosis of acute portal thrombosis is difficult to make clinically and is most often disclosed only at autopsy. Especially is this true in incomplete or sectional arrest of circulation in the portal vein.

The most outstanding symptoms of the condition are due to the severe sepsis, but this is present in many other disorders. When the more definite symptoms of pain in the epigastrium and left abdomen, bloody stools, and a rapid increase in the size of the spleen and perhaps ascites are present, the recognition is easier, especially if an infective focus (like acute appendicitis, pelvic abscess, etc.) are present, In most instances, however, especially in the first week or two, these symptoms are absent. With the deepening of the sepsis, the pain in the abdomen often ceases or becomes eclipsed by other symptoms. Bloody stools are not present in all cases and this is usually more of a late symptom than an early one. The same is true of ascites. This leaves the symptoms of pyrexia and blood findings of the sepsis (which as stated before may be due to conditions other than portal vein infection), and the splenic enlargement which may be masked by the distention of a small intestine ileus or be only moderate and even at times transitory. The chronic form of the disorder is not discussed here.

REPORT OF CASES

CASE I. A male, aged thirty-one, was seized with an acute pain in the epigastrium, vomited and was intensely nauseated for about eight hours. At the twelfth hour after the onset of the illness he was hospitalized and because of a rise in temperature of 3° F. and a leukocyte count of 18,200 with 81 per cent polymorphonuclears, a diagnosis of acute appendicitis was made, and a normal looking appendix was removed. Nothing untoward was noted in the small area of the interior of the abdomen that was exposed except that the cecum appeared slightly congested. The illness continued and on the fourth day after the operation an enlargement of the spleen was noted, the patient continually deepening in a septic state. In about a week the abdomen became distended and a peritonitis was suspected. Because of a continuation of vomiting, a possible intestinal obstruction was thought of and barium was given by mouth and a series of roentgenograms were made. These showed segmentation and general slowing of the barium throughout the small intestine. The patient ran a septic and typhoidal course for six weeks and slowly recovered, being four months in the hospital. The diagnosis finally made was "probably an acute pylephlebitis." A roentgen examination made four months after recovery failed to show any delay in the small intestine and no segmentation.

CASE II. An unmarried woman, aged thirty-two (case of Dr. Earl Halligan of Jersey City), was well up until the time of the present illness. Her illness began with a pain in the left abdomen which had started two months before and which radiated into the thigh and which had continued up to the present illness.

On rectal examination there was an infiltration in the left uterine adnexa and what felt like a mass. On the fourth day after this was noted, she was hospitalized for a possible pelvic abscess. On the sixth day in the hospital her general condition became acutely worse, she became noticeably septic, a diphasic temperature 100° to 102° F., with leukocyte counts on four successive days of 27,700, 31,100, 24,000, and 26,300 and polymorphonuclears of 81, 70, 66 and 78 per cent. Because of a habitual constipation and the possibility of an intestinal obstruction, a roentgen examination with barium was made which disclosed marked delay through the small intestine with pocketing segmentation (Figs. 1, 2, 3, 4 and 5) and a normal colon. Within a day

* Read by invitation, New York Roentgen Society, April 15, 1940, and National Gastroenterological Association, June 6, 1940.

or two after, the spleen and liver became enlarged. On about the tenth day her abdomen became centrally distended due to ileus of the small intestine. The illness continued severe for about nine weeks when she died. Throughout the course the clinical picture was that of an ileus due to portal thrombosis and a terminal peritonitis.

Case III. A man, aged forty-one, had an attack of acute appendicitis with masked and atypical symptoms. He was operated upon on the ninth day after the onset, a congested appendix and a small appendicular abscess being present into which later about half of the appendix had sloughed off and was free in the pus cavity. On the sixth day after the operation

Fig. 1. Case II. Roentgenogram taken three-quarters of an hour after barium by mouth, showing normal stomach, some delay in the second part of the duodenum with spastic first part and dilated second and third part, and distinct delay in the jejunum with marked delay near the end of the first group of coils (the head of the column had not progressed beyond this point even at the end of two and a half hours), this stoppage corresponding to circulatory interference at the beginning of the superior mesenteric veins. This is marked by arrows.

Fig. 2. Case II. The right colon shows a blocking of barium taken twenty-four hours before with some delay in the ileum, and also marked stasis in the small intestine with barium taken six hours before. The shotty dispersion of barium in the upper coils of the ileum and the presence of gas in the lower coils of the ileum both marked by arrows. This roentgenogram represents marked delay in the transit of barium in twenty-four hours in the right colon and marked stasis of barium in six hours in the transverse colon.

(during which time his course was seemingly satisfactory), he was seized with a chill, a rise of temperature to 104° F. and a leukocyte count of 21,400, with 84 per cent polymorphonuclears. The next day his spleen was palpable below the costal margin and his liver was definitely enlarged. A sepsis rapidly developed and on the tenth day after the operation a roentgen examination was made with barium which showed a delay of twenty-three hours in the small intestine with segmentation of the barium. His appendicular wound was healed in four weeks, but he ran a course of pylephlebitis for nearly three months in which three tappings for ascites were required. During this time he had four attacks of melena and two of hematemesis. Six months after recovery the roentgen examination was normal.

FIG. 3. Case II. Roentgenogram taken twenty-four hours after barium by mouth showing a stasis in the ileum, ascending colon and the proximal half of the transverse colon, this corresponding to the end of the area supplied by the superior mesenteric vessels.

Leaving out of consideration the acute forms of thrombosis of the main trunk which usually occurs as a terminal event, most of the instances of portal thrombosis are partial occurring in the splenic or the mesenteric veins. Usually the mesenteric form involves the splenic vein. It is stated that one must have a long standing of the condition with perhaps cavernous transformation of the portal vein for the spleen to enlarge noticeably. Three cases of the acute form have been presented in which splenic swelling was rapid, occurring in a few days. It is interesting that during the early part of the condition, ascites and hemorrhages are not likely to be present, these being symptoms in the later or the more chronic state.

In a condition as difficult to diagnose, and often even to suspect as portal thrombosis, any aid in arriving at a diagnosis of the condition is worth while. There is reason to believe that in the acute cases, at least, valuable information toward the diagnosis of portal thrombosis may be gained by roentgen examination. In the roentgenograms it was noted that the stomach and the duodenum emptied normally and the colon showed no delay beyond the first third of the transverse colon. The entire small intestine from the jejunum down was markedly slowed in its transit function. With barium given by mouth, the small intestine is usually empty in from five to seven hours, and in small intestine obstruction proximate accumulations are suggestive of point blocking. One occasionally notes hypomotility in the small intestine, such as in some cases of late pulmonary tuberculosis, avitaminosis and ulcerative colitis, but in these the slowing is not so marked, the descending limb of the jejunum is never involved, and emptying of

FIG. 4. Case II. Roentgenogram showing accumulation of gas in the small intestine and also in the right half of the colon, this representing blocking of the circulation.

the stomach and duodenum and left half of the colon are also slowed and not normal as in the cases of portal thrombosis. In portal thrombosis, however, it is as if the blocking of the circulation slows down the transit of the barium generally along many feet of the bowel and this is as late as twenty-four or more hours, and instead of the intervening barium between the head and tail being contiguous or showing in a feathery order after six hours, the barium occurs in mass collections with intervening empty areas (segmented), and, where the barium collects, it is seen as dense patches with no suggestion of valvulae conniventes or lumen formation.

There would be interest in noting what these roentgen findings would be in the more chronic case if the findings could be differentiated in the splenic and mesenteric types of portal thrombosis, and if they would be of value in studying the clinical course of a case of acute portal thrombosis.

It is reasonable to suppose in the average case of portal thrombosis that only portions of the superior mesenteric vein are involved. The enlargement of the liver may be caused by deficient portal blood supply to the organ. These cases suggest that only a portion of the portal vein system is involved in the disorder and that the arches and communications are able to maintain a reasonable degree of return circulation from the bowel, this being distinctive in the veins as compared with the arteries in which the collateral and arching system is not so well developed and is more of the terminal order. The vessel supply to the stomach and duodenum suggests in the roentgen findings that the gastric, the short gastrics or the pyloric anastomose with the phrenics, the splenic or the left gastro-epiploic with the renals, the right or left colic with the branches from the fatty capsule of the corresponding kidney, and the duodenal may open into the inferior vena cava, these giving the normal findings in this part of the digestive tract. This, no doubt, is the reason why the stomach and duodenum are not involved in the slowing of function, the spleen may not be enlarged and the left colon is not slowed in its function. The roentgen findings correspond to these various blood vessel distributions. The stomach and duodenum up to the third part are not slowed because the superior mesenteric vein does not drain these parts. The superior mesenteric vein has its beginning in the neighborhood of the jejunum. Distal to the mid-transverse colon the tributaries of the inferior mesenteric take charge, the same isolation from the superior mesenteric veins being the fact with the gastric, pyloric cystic and parumbilical veins. At about the mid-transverse colon, the superior and inferior mesenteric veins (and arteries) anastomose. It is for these reasons that all the roentgen phenomena are only found connected with the small intestine and colon up to the mid-transverse portion.

Fig. 5. Case II. Showing no interference with the function of the colon except twenty-four hour delay of the barium taken by mouth and resting in the cecum. The colon from the proximal transverse colon on was filled in a few minutes by barium clysma and emptied readily leaving accumulation in the right colon.

CLAVICULAR DYSOSTOSIS*

By ALLAN TUGGLE†, M.D., *and* K. L. MITTON, M.D.
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ANOMALIES of the clavicle have been known and described for many years. In 1897 Marie and Sainton[4] gave the name of hereditary cleidocranial dysostosis to anomalies of the clavicle and skull occurring in one family of mother and son and in another family of mother and daughter. Fitzwilliams[3] in 1910 reported 2 cases of the condition and abstracted 59 others reported up to that time. Fitchet[2] more recently in an exhaustive study reviewed the literature and reported further on the "C" family first described by King. He definitely established the anomaly as occurring in three generations. A mother, son and daughter were afflicted. The daughter had no children. The son had four children and of these, three daughters were afflicted and a son was free. A minute roentgenographic study of the six living members of this family showed no unusual cranial or other bony changes. He also reported 2 isolated instances of the disease.

The disease as described in the past may manifest itself by unilateral or bilateral changes in the clavicle, such as absence of the whole or of a part or underdevelopment of the clavicle, especially in its outer portion. There are often associated anomalies of the skull such as increase in breadth, delay in closure of the fontanelles, malformation of sutures, disproportion between face and skull, or large bosses with prominent sutural grooving. Occasionally irregular and delayed dentition with pronounced caries is found. Clavicular deformities accompanied by vertebral synostoses or by anomalies of the sternum or pelvis have been described. Defects have been found in the small bones of the extremities. Stature is generally described as being small but some have found cleidodysostosis in normal and oversized individuals.

Both hereditary and sporadic cases have been reported. Besides the excellent articles by Fitzwilliams and by Fitchet, Anspach and Huepel[1] have recently described a hereditary form occurring in father and three daughters and in this they emphasize a defective cartilaginous mechanism.

Because of the association of the clavicular defects with other abnormalities, especially those occurring in the skull and those involving dentition, and because of the indefinite knowledge of the development of the clavicle, some have assumed that the membranous bones may somehow be selectively affected. In view of the theory that the development of the clavicle is from both cartilage and membrane, with membrane forming the outer part, some have considered this as further proof that the bony defects are purely membranous. This theory has not been generally accepted.[5]

The reported cases indicate that no inconvenience or little apparent weakness results from the deformity, however there may be psychological complications following the discovery of the anomaly. In our case an oversolicitous school nurse upset the family by continually insisting than an operation be performed to remedy the condition.

REPORT OF CASES

Eileen (No. 180540) was referred to the Radiological Department of New York Hospital on November 6, 1937, for a routine chest examination. At that time she was being seen by the Pediatric and by the Otology Service because of middle and inner ear disease. The history reveals a normal birth with no remarkable changes in development except that dentition was delayed until the eleventh month. During her ten years, there had been no unusual disease. Her father was thirty years old, of English

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descent and gave an unrelated family history. The mother was Irish, aged thirty-three, and her past history has been uneventful except for a finding which will be described later. The chest roentgenogram of Eileen was essentially negative except for an anomalous defect in the mid portion of the clavicle (Fig. 1). The inner part was well developed but showed some upward angulation laterally where it was joined by the rudimentary lateral portion of the clavicle and at which point a pseudarthrosis was

Fig. 1. (Eileen) Roentgenogram showing an anomalous defect in the mid portion of the clavicle.

formed. Above this there was a soft tissue mass in the supraclavicular space. Motion was free in this false joint. The history revealed that the swelling had been present for many years. The mother then called attention to a mass in her own right supraclavicular area which had been present since childhood (Fig. 2). She then informed us that her other daughter, Marie, had a similar condition. The mother knew nothing of her own parents but she was sure a sister did not have the anomaly. It was impossible to roentgenograph this sister. She showed no self interest and would not permit the examination.

Roentgenograms were made, however, of the entire osseous system of the mother and of the two daughters. The right clavicle of the mother revealed a defect similar to that of her daughter, the medial part was well developed and there was a cleft in the mid portion with the lateral half being somewhat rudimentary, particularly at the acromial junction. The left clavicle was also poorly developed distally but showed no cleft.

The younger daughter Marie, also revealed a right clavicular anomaly quite similar to that of her sister and mother (Fig. 3). This showed

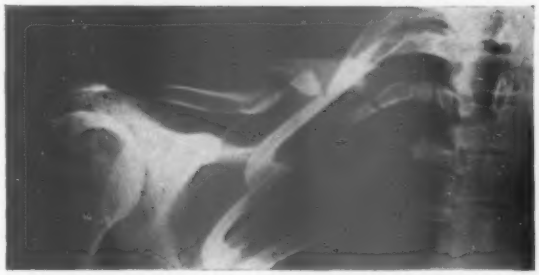

Fig. 2. Roentgenogram showing an anomalous defect in the mid portion of the clavicle in the mother of cases shown in Figures 1 and 3.

some fibrous union to be present but false joint formation was not so pronounced. Except for the changes described in the right clavicles, these three individuals revealed none of the other changes occasionally found with cleidocranial dysostosis.

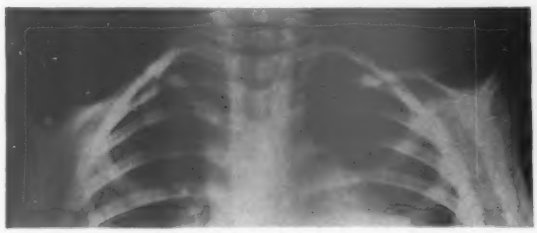

Fig. 3. (Marie) Roentgenogram showing an anomalous defect in the mid portion of the clavicle.

A family showing a hereditary anomaly of the clavicle is added to the literature on clavicular dysostosis.

REFERENCES

1. Anspach, W. E., and Huepel, R. C. Familial cleidocranial dysostosis (cleidal dysostosis); preosseous and dentinal dystrophy. *Am. J. Dis. Child.*, 1939, *58*, 786–798.
2. Fitchet, S. M. Cleidocranial dysostosis; hereditary and familial. *J. Bone & Joint Surg.*, 1929, *11*, 838–866.
3. Fitzwilliams, D. C. L. Hereditary cranio-cleido-dysostosis. *Lancet*, 1910, *2*, 1466; 1475.
4. Marie and Sainton. Quoted by Anspach and Huepel.
5. Todd, T. W., and D'Errico, J., Jr. The clavicular epiphyses. *Am. J. Anat.*, 1928, *41*, 25–50.

BILATERAL CERVICAL RIBS

REPORT OF CASE, WITH FRACTURE OF THE LEFT

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J. A. W., First Lieutenant, Engineering Corps, Reserve, aged thirty, while driving his car collided with a truck near Phenix City, Alabama, a short distance from Station Hospital, Fort Benning, Georgia, to which he was brought June 24, 1936, several hours after the accident.

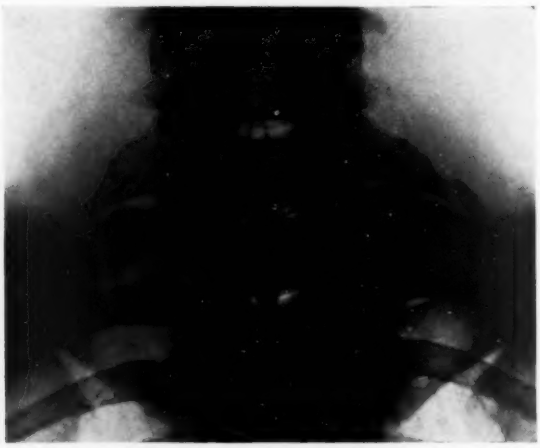

FIG. 1

On admission he was unconscious and had multiple lacerations and contusions of the head, neck and left chest. He slowly recovered consciousness and on July 8, 1936, his head was roentgenographed and found negative. On July 13, 1936, he complained of pain in the neck and, upon roentgenographing the cervical region, bilateral cervical ribs were found attached to the seventh cervical vertebra. On the left side the immature rib showed a complete transverse fracture through the mid portion (Fig. 1).

It is regretted that the dorsal vertebrae and the ribs were not roentgenographed since it cannot be definitely proved that these were not atypically placed immature first ribs. However, the fact that the left is definitely fractured is considered rare enough to be reported.

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UNUSUAL LOCKING OF THE ELBOW JOINT BY THE SESAMUM CUBITI AND A FREE JOINT BODY

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REPORT OF CASE

On May 9, 1938, J. H. McC., aged twenty-eight, was referred to me by Dr. Martin J. Echeverria because of a disability of the right elbow of three to four months' duration. A year before he had been in an automobile accident. He had been thrown out of the car and sustained a skidding injury of the back of the right arm and forearm. This injury was not considered to be serious and he had no particular disability of the elbow. Roentgenograms were considered negative.

He has become unable to extend the elbow completely and he noted frequent catching of the elbow—about 15 times in a day. Sharp pain is experienced with each locking, and radiates to the shoulder. During the phase of locking, the right elbow is held flexed and he can feel a cartilaginous-like body on the back of his right elbow, which seemed to become incarcerated when the elbow was bent quickly. The strength of the upper extremity has remained good. The elbow is stiff for ten to fifteen minutes after arising, and he believes this to be due to his habit of extending his arm under the pillow. The patient is a bartender and he noted difficulty in mixing drinks.

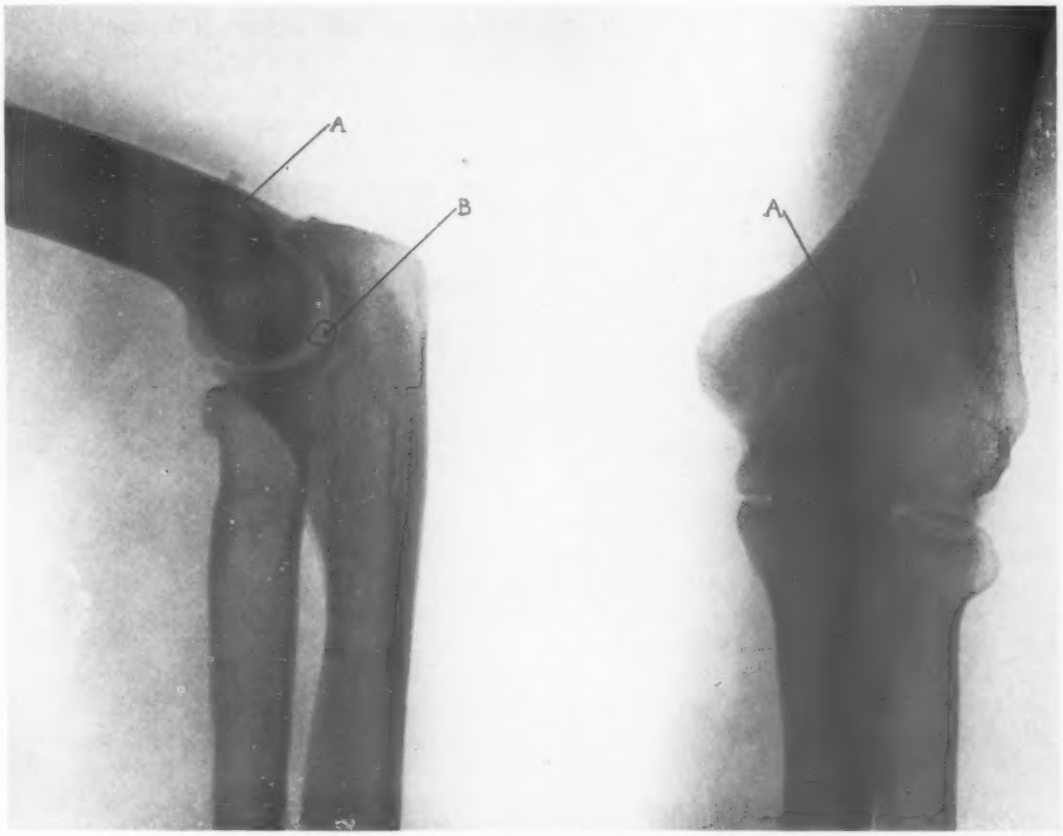

FIG. 1. Anteroposterior and lateral views of the right elbow. *A* indicates the ossiculum cubiti; *B*, the joint body.

Flexion of the right elbow was complete but extension was limited to 155°. A dime-sized circular piece of bone was felt beneath the tri-

ceps muscle about 1½ inches above the olecranon process. This bone overlay the humerus in its mid-longitudinal line. The edges of this anomalous bone were irregular and sharp and the bone itself was quite tender. On flexion and extension of the elbow, especially on flexion, the bone grated and this grating was painful. There was ½ inch atrophy of the right arm 5 inches above the olecranon tip. This tip was not tender. Pronation and supination of the forearm were normal.

The anteroposterior roentgenogram of the right elbow showed a circular body just proximal to the olecranon process which overlapped the most distal part of this body. This body occupied the olecranon fossa. The outline of this fossa was distinct and the width of the zone of separation between the fossa and the body was less than 1 mm. A small fragment was detached medially from the body and at this site the opposing edges were irregular. The body seemed to have been fractured transversely at the level of its inferior third. In the lateral view, it was noted that the depth of the cavity which the body occupied was more than one-half the width of the humerus. The anterior wall of the fossa was sclerotic. A small stalk projected dorsally above the line of the shaft of the humerus. This stalk, which was about ½ inch above the level of the tip of the olecranon process, joined the body within the olecranon fossa so that, in this view, the body seemed to be shaped like a short, narrow-mouthed jug. There was very slight soft tissue swelling overlying the stalk. There was no evidence of fracture of the body in this view. There was no evidence of fracture of the tip of the olecranon. An oblong, atrophic, free joint body with slightly accented borders was poorly seen in the humero-ulnar joint. Similar roentgenograms of the left elbow were negative, and no bony anomaly was seen.

DISCUSSION

The anomalous bone is an occasionally seen sesamoid bone which occupies the olecranon fossa. It is called the sesamum cubiti or ossiculum cubiti. It is not the patella cubiti. The belief that it is a sesamoid bone presupposes a congenital etiology but there are those who believe that trauma in childhood may form this and other similar ossicle formation. In this case, I believe that the ossicle was fractured at the time of accident, and that locking was due both to the catching of the stalk of the sesamum cubiti in the triceps tendon and to the interposition of the free joint body between the joint surfaces. This joint body was undoubtedly detached at the time of accident.

Operation was advised, but was not carried out since the patient left the city a day after the examination.

I am indebted to Dr. Samuel E. Sinberg for his cooperation in roentgenologic interpretation.

REFERENCES

1. Atsatt, R. F. Loose bodies in the elbow joint; unusual location and form. *J. Bone & Joint Surg.*, 1933, *15*, 1008–1009.
2. Grauer, S. Ein atypischer Knochenschatten im Ellbogenbereich. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1927, *36*, 1277.
3. Hirsch, I. S. Foramen in lower extremity of the humerus. *Radiology*, 1928, *10*, 199–208.
4. Kienböck, R., and Desenfans, G. Ueber Anomalien am Ellbogengelenk. *Beitr. z. klin. Chir.*, 1937, *165*, 524–529.
5. Pfitzner, W. Beiträge zur Kenntnis des menschlichen Extremitätenskelets. Zweite Abt. IV. Die Sesambeine des menschlichen Körpers. Morphologische Arbeiten, 1892, 1, 517. Pp. 574–576 and Fig. 4 of Table 25.
6. Zeitlin, A. Traumatic origin of accessory bones at the elbow. *J. Bone & Joint Surg.*, 1935, *17*, 933–938.

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RADIOLOGY IN THE UNITED STATES ARMY

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THE question of training doctors in the intelligent interpretation of roentgenograms has recently been brought to the fore. Since all the discussion in the past has been from the viewpoint of undergraduate training, I do not think it amiss to inform the profession as to what the Army Medical Department is doing in the line of training its members.

The Medical Department of the Army, realizing the importance of radiology in the diagnosis and treatment of diseases and injuries, has, during the past twenty years, been fostering and developing radiology within its ranks.

Since the personnel are scattered throughout the country and in our possessions in large and small stations, it is essential that every medical officer have some training in the technique of making roentgenograms and their interpretation. With this in mind, sixty hours, or about one-eighth of the instruction time allotted to the four month Basic Graduate Course of instruction at the Army Medical School has been allotted to the subject of roentgenology. All medical officers of the Army are sent for this course shortly after their permanent appointment in the Medical Corps. In this instruction about half of the time, or twenty-seven hours, is allotted to the physics of roentgen rays and to the mechanics of machines, including minor repairs, and the technique of making satisfactory roentgenograms. This portion of the course is necessary in that many of our stations are small and isolated and it is necessary for the officers to be their own technicians until they can train soldier assistants; also, it is essential that they be able to make minor repairs to their equipment as the nearest service representative of any of the roentgen-ray manufacturing companies may be many miles distant from their station and to wait for his arrival may make their equipment inactive for several days. The remainder of the course, or thirty-three hours, is allotted to interpretation of the normal and the more common pathological findings of the different portions of the body and the contained organs.

After completion of the course at the Army Medical School these young officers are sent out to the various stations and it has been found that with this basic training, if they are inclined toward radiology as a specialty, they will continue their study in this line. Those who show an interest in the subject at their stations and have made the most of their opportunities by experience and study are then sent to one of the general hospitals of the Army for two to four years further training under qualified radiologists. This training is usually augmented by details of four to nine months with prominent and qualified radiologists in civil practice for training relative to roentgen and radium therapy and additional training in special fields of roentgenology.

The thought behind our training is to have qualified radiologists at all of our general and large station hospitals; to attain this result it is necessary for the Army to have at least thirty-five doctors qualified in roentgenology and at least twenty of these to be also qualified in radiology. Due to the small amount of radiology required in the numerous small stations, it is not deemed necessary to have qualified radiologists on duty at these stations.

It has been found in our teaching at the Army Medical School that the great majority of the students are qualified in physics, but at first are rather hazy on the subject. To refresh their minds and to augment their knowledge of the subject, we have found the visual method of teaching the physics and mechanics to be of more value than didactic lectures. All phases of

the subject are demonstrated with apparatus built in the department at the Army Medical School to demonstrate the point in question, such as the motions of the electron, the actions of magnets, the methods of generating electrical energy, the conversion of direct current into alternating current; the construction and action of transformers, step-up and step-down, and auto-transformers, the construction and action of choke coils and rheostats and the action and the location of voltage compensators. The arrangement and purpose of each piece of apparatus in a roentgen-ray machine is demonstrated by setting up on the wall all the component parts of such a machine with each circuit marked by different colored wires. For this purpose we set up a mechanically rectified (disk) machine and a thermionic rectified (valve tube) machine.

The common causes of minor troubles which may occur in roentgen-ray machines are demonstrated as are the methods of tracing out the circuits and locating the cause of the trouble and how to repair it.

The technical and roentgenographic factors are carefully explained, then by practical experience of manipulating the machines and processing the films these factors are demonstrated to the student in a visual manner.

The following subjects are taught during this portion of the course:

Source and nature of roentgen rays.
Electron therapy (elementary).
Electrical terms, instruments and circuits.
Ohm's law and power law.
Electricity, magnetism, motors and generators.
Direct current versus alternating current.
Symbols used in roentgen-ray diagrams.
Transformers and auto-transformers.
Roentgen-ray tubes, types and ratings.
Circuits of roentgen-ray machines.
Types of rectification.
Bedside and stationary units.
Electrical and roentgen-ray dangers.
Safety factors.
Prime and technical factors.
Sum of a diagnostic film.
Roentgen films.
Intensifying screens and cardboard holders.
Darkroom processing.
Darkroom chemistry.
Darkroom construction.
Darkroom errors.
Practical work in darkroom.
Practical technique.
Localization of foreign bodies (triangulation method).

In the instruction in interpretation the visual method has again been found to be the method of choice. In this portion of the course, normal conditions are demonstrated by the use of roentgenograms showing normal structures of the various parts of the body. Pathological conditions are demonstrated by films showing the more common types of pathology found in the body. The roentgenograms used in this portion of the course are taken from the pathological files of the Department of Roentgenology at the Army Medical School and the X-ray Clinic at Walter Reed General Hospital. During this portion of the course the main features of the pathological conditions present on the roentgenograms are pointed out. When possible, surgical and pathological findings are correlated with the roentgenological findings. At the end of the course the students are given an examination on interpretation by using a series of unknown roentgenograms in which they are required to describe the pathological condition present and arrive at a diagnosis.

LAYMAN TECHNICIAN TRAINING

In addition to the training given medical officers there are given two courses a year, each of seventeen weeks' duration, for the training of enlisted technicians. This course has as its mission the training of enlisted personnel of the Medical Department in the intelligent performance of the technical duties in the field of roentgenology and so train them that they will be familiar, not only with the actual operation of roentgen-ray machines, but also with the proper way of handling patients, of recording and caring for the records and of assisting the roentgenologist in his diverse problems.

A high school education or its equivalent is required for admission to the class.

The applicatory method of instruction is employed throughout. Lectures and demonstrations are given for orientation only.

The time allotted to the various subjects is:

	hours
Roentgen physics	90
Shop work	81
Anatomy	15
Darkroom procedure	28
Technique	100
Potter-Bucky diaphragm	2
Stereoscopic projections	2
Gallbladder technique	4
Gastrointestinal and barium enema technique	8
Written and practical examination	60
Typing and clerical instruction	154

The roentgenologic physics taught is the same as that in the officers' course, but with the addition of more practical application of the subject matter. These men actually build roentgen-ray machines complete, including the winding of the transformers, auto-transformers, rheostats, choke coils and the complete wiring of the control stands.

Anatomy is taught to familiarize the technician with those terms which are commonly used in this field of work. There are included the terms concerning surface anatomy which are used by the clinician in the making of requests for examinations, and also the more important skeletal landmarks which are concerned in positioning in roentgenology, and for the taking of dictation in the descriptive interpretation to be made by the roentgenologist.

In darkroom procedure the nature of roentgen films and the diverse factors concerned with the production of high quality roentgenograms is explained. Darkroom technique is considered thoroughly and errors which may result in faulty films are pointed out. Darkroom construction, light proofing and ventilation, safe illumination, arrangement and care of equipment all receive proper consideration. Loading and unloading of films, and processing with emphasis on time-temperature development and proper care of solutions, the constituents of the developer and the fixing solutions are explained and the solutions made up.

In technique the proper positioning of parts and the manipulation of roentgen-ray units are stressed. In this instruction, landmarks, sites for centering, precautions and indications for additional equipment are emphasized, also conservation of film surface and proper identification of films during exposure. Each student is required to make a complete survey of the skeleton using the mobile bedside unit as well as stationary units, old types and modern.

EQUIPMENT

In order to take advantage of the training given the officers and enlisted technicians and to offer patients the advantage of modern methods of diagnosis and treatment, the Medical Department has equipped each station with sufficient roentgenologic equipment to supply its needs. The smallest station is equipped with a mobile bedside unit, a two-position table with Potter-Bucky diaphragm and a portable fluoroscopic screen. The largest station hospitals and the general hospitals are supplied with a complete line of stationary equipment as well as two or more mobile bedside machines for roentgenography and 220 kilovolt machines for therapy. Three of the general hospitals are supplied with radium element.

In addition to the peace time equipment the problem of field equipment is being thoroughly investigated. At the present time an experimental field roentgenoscopic unit is being developed. This unit will weigh about 850 pounds when packed and will be transported in five standard field medical chests. It will consist of an alternating current generator of 1 kilowatt capacity enclosed in a double height field chest with a combined weight of about 250 pounds, a folding field table which can be knocked

down and packed in a chest. The weight of the table will be about 62 pounds; two shockproof roentgenographic heads of 5 milliampere, 80 kilovolt capacity, one of which will be swung under the table on a cradle attached to the support for the fluoroscopic screen. The tube head will be coned to show a circle of roentgen radiation of 3 inches when the top of the screen is 10 inches from the focal spot; a control stand which will be swung on a bracket at the end of the table; a fluoroscopic screen 25 by 25 cm.; foreign body localizing insert for screen; detachable, lightproof hood for screen; lead rubber aprons, lead rubber gloves, goggles, foot switch and connecting cables.

The foreign body localization method will be by triangulation and the device will consist of a transparent insert for the top of the fluoroscopic screen; the marking on this insert must be laid out in four directions from the center in 0.5 cm. divisions; the relation between the size of these divisions and the depth of the foreign body will be as one is to three, the accuracy of this insert depending upon the angle of the ray coming from the tube head. This to be exactly 18 degrees, 26 minutes and 48 seconds from the central ray or a total cone angle of 36 degrees, 53 minutes and 38 seconds. The target of the tube must be located 30 cm. below the litter top.

Due to the 19 degree angle of the anode of the line focus tube, a cone is not essential because the tube shift will be toward the cathode.

There is also being developed a heavier field machine with a capacity of 30 ma. at 100 kv. which can be mounted on a chassis for use as a mobile bedside unit.

Thus it will be seen that the Army is very conscious and appreciative of the value of radiology in the practice of medicine and is doing its utmost to bring this specialty to the highest state of efficiency by adequate training of its doctors and technicians and the provision of up-to-date equipment.

THE EXPLOSION AND FIRE HAZARD OF ANESTHETICS IN THE PRESENCE OF ROENTGENOLOGIC APPARATUS*†

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INTRODUCTION

THE need for this article would be obviated were the choice and administration of anesthetic agents in all hospitals and offices guided by physicians educated in the basic physical, chemical and clinical facts of anesthetic agents and their combustion. The purpose of this article is to elaborate the knowledge which, if applied at all times, could reduce to zero the number of explosions and fires caused by such obviously spark-producing equipment as roentgen-ray apparatus.

The danger of operating roentgen-ray equipment near combustible anesthetics has long been known but the knowledge is very inadequately distributed among roentgenologists. Explosions and fires due to roentgen-ray equipment are still recurring and hazardous techniques are still widely recommended and used.

PHYSICAL AND CHEMICAL DATA

The following conditions must co-exist to permit the occurrence of an explosion or fire: (1) a combustible agent must be mixed in (2) certain proportions with (3) a source of oxygen in the presence of (4) heat of sufficient degree.

(1) The combustible anesthetics are ordinary or di-ethyl ether, ethylene, cyclopropane, divinyl ether (vinethene), and ethyl chloride.

(2) The inflammable proportions are:

Ether in air	1.85 to 25.9%	(9)‡
Ether in oxygen	1.8 to 50.0% or more	(5)
Ether in nitrous oxide-oxygen	probably wider range because of nitrous oxide	(10)
Ethylene in air	3.05 to 28.6%	(9)
Ethylene in oxygen	3.10 to 79.9%	(9)
Cyclopropane in air	2.4 to 7.3%	(5)
Cyclopropane in oxygen	2.5 to 50%	(3)
Ethyl chloride in air	4.3 to 14.0%	(11)
Divinyl ether in air	1.7 to 27.0%	

‡ Figures in parentheses here are to bibliographical references.

The limits of inflammability are all within the ranges used in clinical anesthesia. No one agent shows any significant advantage with respect to narrowness of range. The use of air instead of oxygen narrows the range of possible combustion and decreases the violence of explosion and the rate and distance of propagation of a flame.

(3) A source of oxygen in combustion may be air, oxygen from a cylinder or nitrous oxide. The addition of nitrous oxide increases the range and force of explosion even more than does oxygen.

(4) Heat of sufficient degree to ignite a combustible mixture is probably present whenever an electric spark appears; and, as will be described below, sparks are readily produced in roentgen-ray apparatus and rooms. The ignition points of liquid ether, and mixtures of ether with air, oxygen or nitrous oxide-oxygen are at least 300° C. below visible spark temperatures and several hundred degrees lower than those of ethylene-oxygen mixtures.[2,4]

Additional factors favoring the occurrence of anesthetic fires and explosions during the operation of roentgen-ray equipment are the limited ventilation usually present in roentgenologic rooms and the static electricity easily produced on the in-

* This is one of a series of papers by the Committee on Anesthetic Hazards, Dr. Barnett A. Greene, Chairman; this group acting as a Research Subcommittee of the American Society of Anesthetists, Inc.

† My sincere thanks and appreciation are here expressed for the expert advice on roentgenologic apparatus and electrical problems freely given by Mr. I. H. Blatz, physicist to the Brooklyn Cancer Institute, Department of Hospitals, New York City.

sulating material, such as rubber or linoleum generally recommended for the flooring of roentgen-ray rooms.

It should be obvious that the use of any of the combustible anesthetic agents, especially ether-oxygen and ether-nitrous oxide-oxygen, sets the scene for a damaging or fatal explosion or fire should a spark be produced.

CLINICAL DATA

In 1929 the National Board of Fire Underwriters stated that "safe practice dictates the absence of such apparatus (X-ray fluoroscopic equipment) in the presence of combustible anesthetics."[13] The International X-ray and Radium Protection Committee at the Fifth International Congress of Radiology in 1937 unequivocally stated: "Low flash-point anesthetics should never be used in conjunction with X-rays."[8]

In spite of these warnings, the dangerous practice persists chiefly because many surgeons and technician and novice-anesthetists are still not aware of the hazard. One large hospital in Brooklyn has forbidden the use of ethylene and cyclopropane in the operating rooms yet freely permits the use of ether-air and ether-nitrous oxide-oxygen in the roentgen-ray room. A large group of Philadelphia physicians and surgeons proudly report that for the "fluoroscopic reduction of fractures vinyl ether has practically supplanted every other anesthetic in our clinics. No special precautions have been taken during the use of X-ray except to stop dropping the anesthetic while the fluoroscopic screen was being used."[12] Some physicians are entirely indifferent to the hazard even after being cautioned, because of the apparent rarity of explosions. We have learned of only ten anesthetic combustions ignited by roentgenologic apparatus. This group forms a very small fraction of the 230 anesthetic fires and explosions due to all causes. Anesthetic explosions and fires in roentgen-ray rooms occur, undoubtedly, more commonly than is generally believed or known. These incidents are hushed up by the persons and hospitals concerned for obvious reasons. But even one explosion due to roentgenologic apparatus is not to be excused, for such an explosion is completely preventable by the use of non-combustible anesthetic agents and methods. Surgical and diagnostic procedures requiring anesthesia under roentgen exposure lend themselves readily to local, regional, spinal, intravenous, rectal or nitrous oxide-oxygen methods separately or in various combinations. Furthermore, these methods are safer in the hands of a competent anesthetist than is ether (the usual anesthetic) administered by a technician or novice-anesthetist.

Some physicians feel safe in using a combustible anesthetic mixture if the roentgen equipment is of modern shockproof type. Shockproof apparatus in general use today diminishes the hazard but does not completely eliminate all sources of igniting sparks. Further details supporting this statement are given later in this paper.

The dangers are most strikingly emphasized by the reports of the fires and explosions secured by the Committee.

CASE I. Ether-air anesthesia by the open drop method. A stoppered can of ether spilled in the pocket of the anesthetist and ether dripped to the floor. As the anesthetist sat on the roentgen table holding a mask covered by a wet towel on the patient's head, a flame suddenly shot out from the table and up his side to the ether can in his pocket. No injury to anyone.

CASE II. Open drop ether given while a roentgenoscope was in use for the reduction of a fracture. The explosion caused transient deafness in the surgeon.

Comment. Cases I and II illustrate the relative safety of either-air mixtures because of non-propagation of ether-air flames into the tracheobronchial tree of the patient.

CASE III. Ether-nitrous oxide-oxygen was given by the partial rebreathing technique for reduction of a fracture. The explosion, ignited by a spark from the roentgenoscope, killed the patient and wrecked the anesthesia apparatus.

Comment. This case and Cases IV and

VII show the greater tendency of ether-oxygen and ether-nitrous oxide-oxygen mixtures to injure the patient by propagation into the air passages.

CASE IV. Ether-nitrous oxide-oxygen administered by the partial rebreathing method for five minutes when the roentgenoscope was used for the reduction of a fractured femur in a child, aged thirteen. The explosion shattered the mask and delivery tube leading the gases to it. The patient vomited blood twice during the next eight hours. The lungs remained normal and the child recovered completely.

Comment. The physician reporting this case implied the belief that the risk of a repetition of an explosion has been eliminated by the installation of modern roentgen apparatus. He apparently failed to recognize the danger of using any combustible anesthetic in the presence of any conventional roentgenologic set-up. Subsequently, this was forcefully pointed out to him in an open letter by Dr. Chalmers-Frances.

CASE V. Open drop ether anesthesia for removal of a needle from the knee of a child, aged twelve. When the portable roentgen machine was turned on, a spark ignited the towel wrapped about the mask. No injury resulted.

Comment. This anesthetist failed to learn the correct lesson from this occurrence for he stated that this could be prevented by discontinuing the dropping of ether while the roentgen machine is being used and covering the mask with a dry towel.

CASE VI. Ether anesthesia. No further data could be obtained from the physician.

CASE VII. Ether-nitrous oxide-oxygen given by a partial rebreathing technique for the reduction of a leg fracture in an adult under the roentgenoscope. Anesthesia had lasted ten minutes when the explosion occurred. The patient suffered ecchymosis of the eyelids and epistaxis but recovered completely.

Comment. The anesthetist reporting the case blamed a fault in the roentgen machine. Therefore a new machine was obtained. He then stated that "combined nitrous oxide and ether anesthetic had been used in many previous cases and some since for reductions." This anesthetist has not yet learned all the hazards of roentgenologic equipment, even of the modern type.

CASE VIII. Cyclopropane-oxygen anesthesia by a complete rebreathing method for reduction of a fracture of a forearm in a boy, aged eight, under roentgenoscopy. The explosion followed five minutes of anesthesia. The patient's cheek was slightly burned. The anesthetist sustained a leg burn and persistent numbness of the left leg, thigh, forearm, and fingers for several weeks. The tubing and mask were noted to be wet and about a teacup of water was found in the rebreathing bag. "Approximately 100 per cent humidity in the machine."

Comment. The anesthetist added that no change in anesthesia practice had been made despite this event and that the accident was not preventable in the light of present knowledge. It is clearly shown by this case, as well as by theoretical considerations, that the closed circuit method of administering anesthetic gases does not provide a sure protection against explosions in roentgenologic rooms, even though it prevents the escape into the room of a significant volume of anesthetic gas or vapor and it secures a very high relative humidity in the respiratory passages of the patient and machine.

CASE IX. Cyclopropane-oxygen anesthesia by complete rebreathing circuit for roentgenoscopic reduction of a Pott's fracture. "After the manipulation was completed a portable x-ray apparatus was brought into the cast room and a picture was to be taken without interrupting the course of the anesthesia. The x-ray apparatus was not one of the new shock-proof type, and one of the wires leading to the tube was too close to the operating table. When the current was turned on, sparks jumped between the wire, the table and the patient at various points. The current was immediately turned off, probably being on about one second or less. The anesthetist was knocked from the stool to the floor, and at the same time the closed system was broken by the release of the face mask. The anesthetist suffered a slight burn on the buttocks where he had been in contact with a metal stool. Two assistants had their fingers slightly burned. No fire or explosion occurred. The patient was un-

affected. It is our impression that the favorable outcome of this case shows the value of using the closed carbon dioxide absorption technique when an explosive mixture is being used in connection with x-ray equipment."

Comment. The closed circuit system prevented an explosion outside of the machine and the patient by not allowing the escape of any combustible mixture into the room when the sparks were flying. It is probable, however, that the closed system contributed nothing to preventing a spark from appearing within the respiratory passages or machine (see Case v). It was just chance that the course of the electrical energy led through the anesthetist and not through a gap in which there lay an anesthetic mixture, e.g., between the mask and the patient's face. The proper deduction to make from this incident is that the rarity of a serious accident in anesthesia is not a proof of its safety. Fate is often kinder than we deserve and only occasionally exposes our ignorance or indifference of the many safeguards erected by the accumulated experience of the past and intended to prevent injury by known hazardous practices.

Case x. Nitrous oxide-oxygen-ether by partial rebreathing for surgical exposure of a carcinoma of stomach. Direct roentgen irradiation of the lesion was being administered in the roentgen room when an explosion occurred in the trachea of the patient. The patient died.

Comment. This is the only explosion known involving the therapeutic application of roentgen radiation but the continued use of this hazardous set-up of roentgenologic apparatus and combustible anesthetic is sure to cause recurrences of this type of catastrophe, especially with the increasing tendency for the application of "contact therapy."

ROENTGENOLOGIC DATA

The solution of the problem of safe anesthesia in the presence of roentgen apparatus has been sought by attempting to eliminate all possibilities of sparking in the roentgenologic room. Static electrical sparks have not been considered as part of this problem because they are developed under circumstances not peculiar to roentgen equipment and rooms. Furthermore, the measures known to eliminate electrostatic sparking do not prevent the sparking in roentgenologic apparatus. It is apropos to point out here that static electricity probably is a greater hazard in the roentgen room than in the operating room because of the greater frequency of movement of the patient, staff, and anesthesia equipment over insulated flooring material in the roentgen room.

The possible sources of a spark in roentgen-ray rooms are so many that the mere listing of them should be impressive.

A. Under normal operating conditions:

1. Arcing switches, if not sealed or removed from the roentgen room.
   - Main switch.
   - Roentgen-ray switch.
     - Hand switch; foot switch; magnetic contactor; timer contacts.
   - Overload circuit breaker.
   - Autotransformer control.
   - Rotary rectifier switch.
   - Open interrupter.
   - Auxiliary equipment control switches.
     - Potter-Bucky, plate changer and stereo tube shift—if electrically operated and controlled.
     - Room light switches.
2. Charged conductor (which may spark to a person or another conductor).
   - Any unshielded part of the high tension system, e.g., reel cord, tube terminal.
   - Any ungrounded or poorly grounded metallic part of the equipment or metal utensil or metal furniture near the equipment charged by induction. Sometimes a person may be charged to cause a spark to ground. Induced charges may be retained even after the equipment has been shut off.
3. High tension arcs.
   - Any point in the high tension system where there is a poor contact or friction contact. Because of the nature of the high voltages and low currents used, it is common practice to have such conditions in any roentgen machine, e.g.,

anode tube connection by means of a ring and hook.

B. Under abnormal operating conditions:
   1. Any defect causing arcs.
      Insulation breakdown.
      Insufficient clearance between high tension conductors and ground.
   2. Application of excessive voltage on high tension circuit causing corona or arcing, e.g., by error in setting controls, by excessively gassy tube, by failure of roentgen tube filament or of valve tube.

To determine whether further technical improvement of roentgenologic equipment could entirely eliminate the hazard created by sparking, we solicited the written opinions of the engineering departments of the leading manufacturers of roentgenologic apparatus. The answers of two of the manufacturers showed a complete lack of understanding of the problem. The other five companies displayed excellent comprehension of the hazard and their reports came to approximately the same conclusions, namely:

1. It is possible to develop equipment that would be sparkproof under all circumstances
2. Very few, if any, of the modern shockproof diagnostic roentgen outfits used today are completely sparkproof.
3. The cost of manufacturing and servicing completely sparkproof apparatus would be significantly higher than that of the conventional shockproof apparatus.
4. A completely sparkproof equipment could be secured by following these recommendations:
   a. The roentgen tube should be oil-immersed and in a grounded metal container.
   b. The transformer and rectifying tube, if any is used, should be oil-immersed or be located outside the roentgen room.
   c. The connecting cables and cable sockets should be of shockproof construction.
   d. The control panel should be located outside of the roentgen room.
   e. The foot switch should be vaporproof or enclosed in a bag.
   f. The filament control switch should be sparkproof.
   g. No part of the high tension wires in the roentgen room should be exposed or ungrounded.
   h. All low voltage connecting wires in the roentgen room should be specially treated, regularly inspected and replaced as they deteriorate.
   i. Electric light switches in the roentgen room should be vaporproof.

We know of no institution in which the roentgenologic equipment, even of the most modern type, conforms to the above outline of necessary safeguards for the complete elimination of sparks. This is confirmed by the very wide experience of Mr. I. H. Blatz, roentgen-ray physicist with the Department of Hospitals of the City of New York and consulting physicist to many private hospitals and roentgenologists.

Although complete protection against sparking is not provided yet a considerable increase in safety from sparks can be secured by the installation, maintenance and repeated inspection of the conventional modern shockproof apparatus. This is borne out by the fact that none of the known explosions and fires have occurred in the presence of shockproof equipment. But this must not be taken to mean that it is safe and justifiable to use combustible anesthetics in the presence of the conventional shockproof but not completely sparkproof apparatus. "Past experience has proved that the most effective precaution against unfortunate accidents in the X-ray laboratory is to use only equipment which is 100 per cent electrically safe under all operating conditions."[6] This statement was issued by the General Electric X-ray Corporation with reference to the hazard of electric shock but it applies equally well to the danger of anesthetic combustions.

The use of shockproof apparatus has become widespread despite the initial financial burden and the very low incidence of electric shock in clinical roentgenologic work. Similarly, the universal adoption of safe anesthetic technique in the roentgen room is indicated even though an explosion

is an apparent rarity. Either completely sparkproof equipment should be installed or non-combustible anesthetic methods and agents be used. The latter plan is the more practicable and is undoubtedly the safer from all points of view, including that of the electrostatic sparks.

The damage of one explosion or fire, considered only from the financial viewpoint, may be costlier than the routine use of non-combustible methods requiring the skill of highly trained anesthetists. The most important consideration, however, is the humanitarian need to safeguard the body and life of the patient and hospital staff surrounding the patient at the time an anesthetic is being given in the roentgen room.

To use an explosive agent in the presence of roentgen rays is to subject the patient to a danger far greater and more serious than is the usual disease for which the patient is being roentgenographed under anesthesia, and is to expose the hospital and staff to damage suits that may cost more than all the savings made by the hospital or physician who employs technician or novice-anesthetist supplying only combustible inhalation anesthesia.

SUMMARY

Explosions and fires of anesthetic agents caused by roentgenologic equipment still recur.

Ten explosions and fires are known (8, ether; 1, ethyl chloride; 1, cyclopropane). The 3 ether-air accidents caused no injuries.

Two patients died and 2 more were seriously injured in those cases involving ether-nitrous oxide-oxygen.

One cyclopropane-oxygen explosion caused a slight burn of the patient's cheek and a serious injury to the anesthetist.

All the procedures during which a fire or explosion happened were roentgenoscopic except one. All the surgical indications were injuries or disease of parts of the body readily anesthetized by local or regional blocks.

The closed circuit method of administration of a combustible anesthetic does not make the anesthesia completely safe from ignition by sparks generated during the use of roentgenologic equipment.

The use of the conventional shockproof roentgenologic apparatus decreases but does not eliminate the hazard of combustion. A completely sparkproof roentgen-ray room is possible but is less practicable, more expensive and less safe than the use of non-combustible anesthetics.

The physical and chemical qualities of the mixtures of air, oxygen or nitrous oxide with ether, ethylene, cyclopropane, vinyl ether or ethyl chloride make them all equally and dangerously susceptible to ignition.

The recommended non-combustible anesthetic agents and techniques are local, regional, spinal, intravenous and rectal drugs and routes of administration, and inhalation methods using nitrous oxide-oxygen alone or supplemented by one of the non-inhalation methods.

The surgical and diagnostic procedures requiring the presence of roentgen rays during anesthesia are more readily and safely performed under the non-combustible agents in the hands of a competent anesthetist than under ether anesthesia given by a technician or novice-anesthetist.

An attitude of indifference because of unawareness of the risk and a feeling of safety because of the statistical rarity of known combustions are still widespread, even among anesthetists and surgeons.

In the forthcoming new edition of the "Recommended Safeguards for the Installation and Operation of Anesthetical Apparatus Employing Combustible Anesthetics" to be issued by the National Board of Fire Underwriters the warning is again to be stated, "In the operating room and elsewhere the use of X-ray machines in the presence of any combustible anesthetic should be prohibited."

Violation of this dictate of thorough investigation and sound judgment is likely to cause, sooner or later, the erring hospital or physician to regret a completely avoidable injury, death or malpractice claim.

ADDENDUM

Two important facts have come to my attention since writing this paper.

1. Dr. Paul Wood has correctly pointed out the necessity of stressing, what might otherwise be overlooked, that certain very unusual situations may require the unforeseen and sudden use of roentgen apparatus during the course of a combustible inhalation anesthesia, e.g., the emergency use of a roentgenographic machine to aid in the search for a lost or broken needle during a pneumonectomy. Under these unusual circumstances it might be more hazardous to substitute another and non-combustible type of anesthesia than to chance the use of the roentgen apparatus in the presence of the combustible anesthetic. With this, I agree. Furthermore, the same principle and considerations of comparison of hazards must be made to apply to those instances when the only anesthetist available is one whose training is so limited as to make the use of a non-combustible anesthetic technique more hazardous than the risk involved in the use of a roentgen apparatus in the proximity of a combustible anesthetic. In this case it is safe for the patient, though not for the anesthetist or surgeon, that the technician or novice-anesthetist administer ether-air by open drop or insufflation. It appears, however, that such a reason rarely accounts for the use of a combustible anesthetic in the presence of roentgenologic apparatus. In my experience it has always been unawareness or disregard of the hazard.

2. A new hazard has been added to those already produced by the use of roentgenographic equipment. This is a newly introduced but already widely distributed roentgen therapy apparatus which is mobile and designed to give "contact therapy" to organs under surgical exposure in the operating room. These machines are shockproof but not completely sparkproof. Therefore, we should apply the same principles of safe practice in the presence of this type of roentgen apparatus as has been advised above for use with shockproof but not sparkproof diagnostic apparatus.

REFERENCES

1. Beck, A. Die Explosionsgefahr bei der Sauerstoff-Aethernarkose. *Zentralbl. f. Chir.*, 1926, *53*, 3028–3032.
2. Blomfield, J. Recent investigations concerning nitrous oxide, and ignition points of anaesthetic vapours. *Proc. Roy. Soc. Med.* (*Sect. Anaesthetics*), 1926, *19*, 39–49.
3. Buchman, M. A., and Wardell, C. M., Jr. Inflammability of Anesthetic Gases and Vapors Including Cyclopropane. Reprint 112. Ohio Chem. & Mfg. Co., Cleveland, Ohio.
4. Dixon, H. B. Inflammability of ether-oxygen mixtures. *Brit. J. Anaesth.*, 1925–1926, *3*, 206.
5. Finch, G. I. Electrical ignition of explosive anaesthetic mixtures. *Proc. Roy. Soc. Med.*, 1935, *28*, 1130–1133.
6. General Electric X-Ray Corporation. Pub. 7B-207, p. 2.
7. Henderson, Y. Hazard of explosion of anesthetics; report of committee on anesthesia accidents. *J. Am. M. Ass.*, 1930, *94*, 1491–1498.
8. International Recommendations for X-Ray and Radium Protection. Am. J. Roentgenol. & Rad. Therapy, 1938, *40*, 134–138; also, *Radiology*, 1938, *30*, 511–515.
9. Jones, G. W., and Kennedy, R. E. Extinction of ethylene flames by carbon dioxid and nitrogen. *Anesth. & Analg.*, 1930, *9*, 6–11.
10. Ministry of Health, London, England. Precautions against Anaesthetic Explosions in Operating Theatres. Memo 191, Med., 1936.
11. Phillips, V. B. Safeguarding the operating room against explosions. *Mod. Hosp.*, 1936, *46*, 81.
12. Ravdin, I. S., *et al.* Further experiences with vinethene anesthesia. *Anesth. & Analg.*, 1938, *17*, 176–180.
13. Recommended Safeguards for Installation and Operation of Anesthetical Apparatus Employing Combustible Anesthetics. National Board of Fire Underwriters, New York City, 1929.
14. Williams, H. B. Explosion hazard in anesthesia. *J. Am. M. Ass.*, 1930, *94*, 918–920.

THE POLAROID STEREOSCOPE

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THE value of being able to create on a two-dimensional surface a faithful representation of a three-dimensional view of an original object has long been appreciated. A means for creating such representations provides many of the advantages inherent in original three-dimensional viewing and at the same time provides many of the advantages inherent in two-dimensional representation (i.e., ease in storage and transportation, permanent records of transient phenomena and opportunity for study when the object is not at hand or when the object is too large or too small for viewing conditions where study and examination are possible).

As applied to roentgenograms, means for three-dimensional representation are of special value since they provide the only convenient means of viewing the original object three-dimensionally. This paper describes, in general, a new system of three-dimensional representation and, in particular, a new device for viewing three-dimensional roentgenograms.

PREVIOUS SYSTEMS

The principles of binocular vision have been known since the researches of Wheatstone, and through the photographic process, have been applied to provide the desired three-dimensional impressions. For relatively small pictures the two images have been placed side by side in a frame to be viewed by the aid of a specially made set of binoculars attached to the frame. Larger images are suitably illuminated and viewed in a similar manner; the main difference in the viewing systems for larger images lies in the elaborateness of the optical systems used for presenting the separate images to their respective eyes. A typical example of this is the Wheatstone stereoscope which employs mirrors or prisms for bringing the images into the line of sight with adjustments which make it possible to compensate for differences in the observer's eyes.

All these systems, upon examination, provide very well for the creation of a stereoscopic impression for a single observer, since complete correction of almost all eventualities can be provided by optical means. They possess, however, one shortcoming—that of providing the stereoscopic view to but one observer at a time, unless very elaborate optical viewing systems are employed, and at best, then, the number of observers is limited.

For those places where the simultaneous viewing of a stereoscopic image by a group of observers is necessary, some different scheme must be used to present two images to each observer. The method should call for a minimum of equipment, especially where multiplicity is concerned.

One such arrangement, the so-called anaglyph, employs band-pass complementary color screens to provide the proper image for each eye. This system has been used in the exhibitions of stereoscopic motion pictures at various times. Its general theory, so far as the creation of the stereoscopic impressions is concerned, is essentially the same as that to be discussed below; but the means of accomplishment is quite different. The disadvantage in this system lies in the fact that in the case where the observer has one dominant eye, that one will receive a stronger impression which will be colored by the screen serving that particular view. Further difficulties are to be found in determining the proper intensity of illumination for each transparency. To make them appear of equal brightness it is necessary to consider the density of the screens together with the average sensitivity of the eye to that region of the spectrum.

THE POLAROID STEREOSCOPE

Through the invention, by Edwin H. Land, of large area light-polarizing material[1-6] and the invention by Land of a viewing device[7] making use of these materials, it is now possible to achieve multiple viewing without any of the limiting disadvantages of the color anaglyph system and at the same time to achieve the greatest simplicity and ease of viewing that it has been possible to obtain even from the lens and mirror system.

New sources of illumination operating at low temperatures and in small space have aided in realizing the practical form of the instrument to be described here.

BINOCULAR VISION

By the theory of binocular vision we are able to see objects in three dimensions by virtue of the fact that our two eyes inspect the same scene each from a different viewpoint. Thus the image received by one eye is slightly different from that received by the other. The two different image impressions are combined in the brain to provide a conception of the solidity and space arrangement of the objects within the field of vision.

From this, if two pictures be made of an arrangement of objects, one from a given point, and the other from a point slightly removed (horizontally) from the first, and the resulting pictures be viewed in some device such that the right eye sees only the view made from the right viewpoint, and the left eye sees only the view made from the left viewpoint, the observer will see a recreation of the original arrangement of objects.

THE STEREOSCOPIC ROENTGENOGRAM

In the making of stereoscopic roentgenograms the same end-results (pictures) are achieved by taking two roentgenograms by first shifting the tube in a plane parallel to the film a small amount from the normal to the film plane and making one exposure; a second is made by replacing the exposed film by a fresh one and moving the tube to a similar position on the opposite side of the normal (the shift being in a line parallel to the length or width of the film) and making an identical exposure. It is customary to make the total shift such that it subtends the same angle at the target-film distance that the interpupillary distance subtends at the viewing distance (approximately 3 feet).

A roentgenogram is a shadowgraph giving a projection on a film of the objects between the film and the target. Since the target-film distance is usually made as large as possible to minimize distortion (resulting from non-collimated radiation) the image on the film will be found quite similar to photographs in general outline; they differ notably in one respect, since the radiation penetrates solid matter to greater or less degree depending on its density, in the image those parts of objects lying behind others will not be invisible as in the conventional picture, but will appear as if partially visible through the object in the foreground. This, together with the fact that the roentgenogram is a negative photograph, will cause some difference in the ease of receiving the stereoscopic impression, for the visual clues found in conventional pictorial representation are missing.

If these two roentgenograms are then introduced into a viewing device which presents each eye with its proper image the observer will receive a stereoscopic impression and will see a reconstruction of the original object-space. For making exact observations and measurements, it will be necessary to have the entire viewing and recording system calibrated and the viewing distance definitely known. For general observation these conditions need not be adhered to rigidly, and an excellent idea of depth relations in the object-space can be obtained.

The problem of devising a means for securing the reconstruction of the object-space, as mentioned above, has been solved satisfactorily for a single observer, and for precision measurement work the devices so made are quite satisfactory. To minimize

the complexity and expense involved in building a stereoscope for several viewers, one thinks immediately of the use of some sort of spectacles to be worn by the observers which will discriminate between the two different images.

The new Polaroid light-polarizing material now offers a practical means for

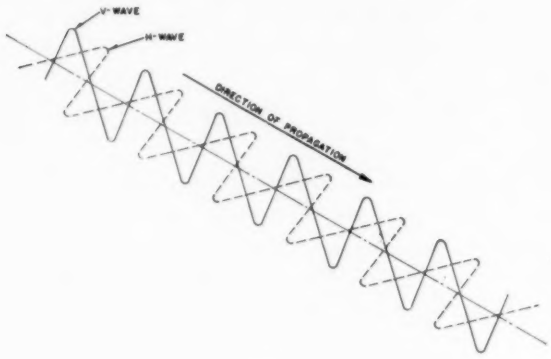


FIG. 1

achieving this discrimination and its availability in large areas makes possible the construction of a device which has none of the shortcomings of the standard stereoscopes and overcomes difficulties which have beset multiple viewing up to this time.

POLARIZED LIGHT

To explain the functioning of this stereoscope let us first review the interesting properties of light upon which its effects depend. It is convenient to consider a single ray of light as a set of two wave trains, *H* and *V*, each vibrating in a plane at right angles to the other (Fig. 1). In order to visualize the behavior of polarized light and the operation of light and the operation of light polarizers, it is useful to consider the polarizer as a barrier fitted with parallel optical slots. Let us imagine such a barrier placed in the path of a beam of ordinary light (Fig. 2). Such a barrier will prevent the *H*-wave from passing, while the *V*-wave is allowed to pass unaffected and this *V*-wave is said to be polarized after passing through the barrier.

Another such barrier (B_2) placed in the path of the *V*-wave (having passed the first barrier) would have no effect on the *V*-wave so long as it was in the same relative position as the original barrier. However, by keeping it in its same plane but rotating it through an angle θ (Fig. 3), it will cause a reduction in the amplitude of the *V*-wave, so that if the original ampli-

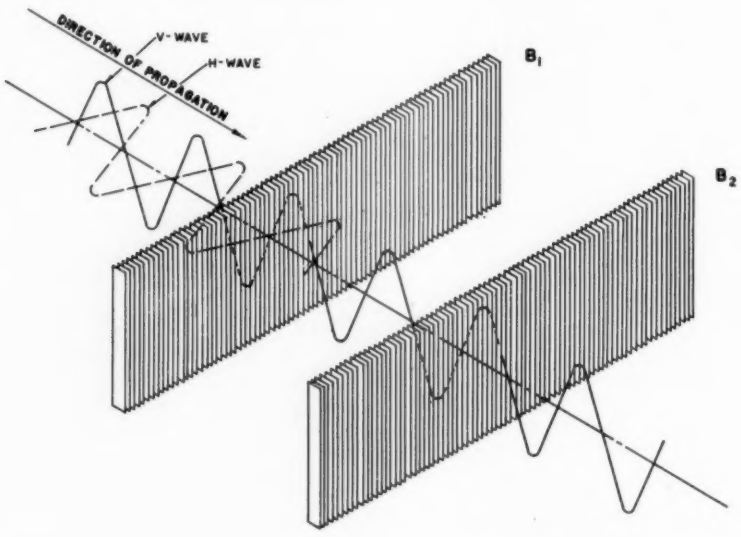


FIG. 2

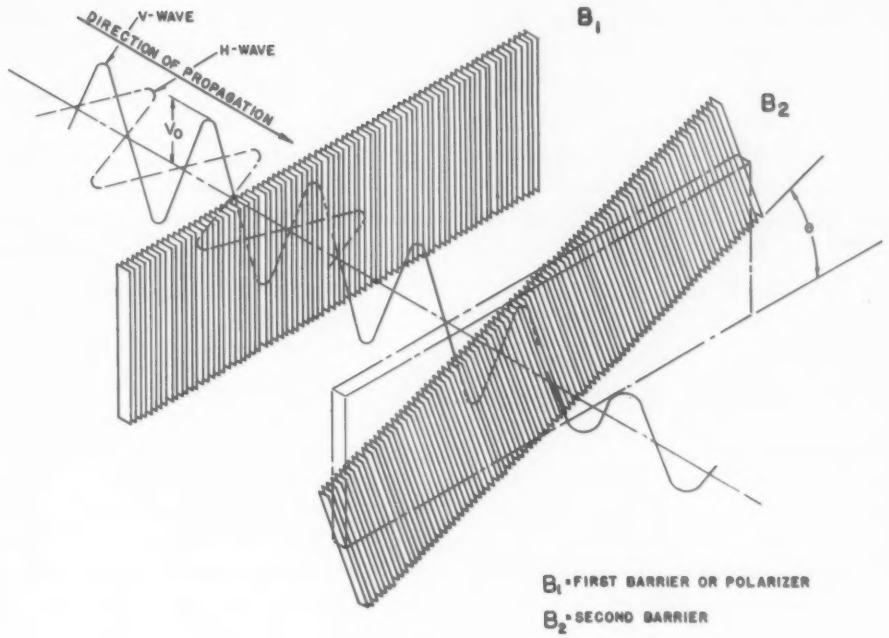


FIG. 3

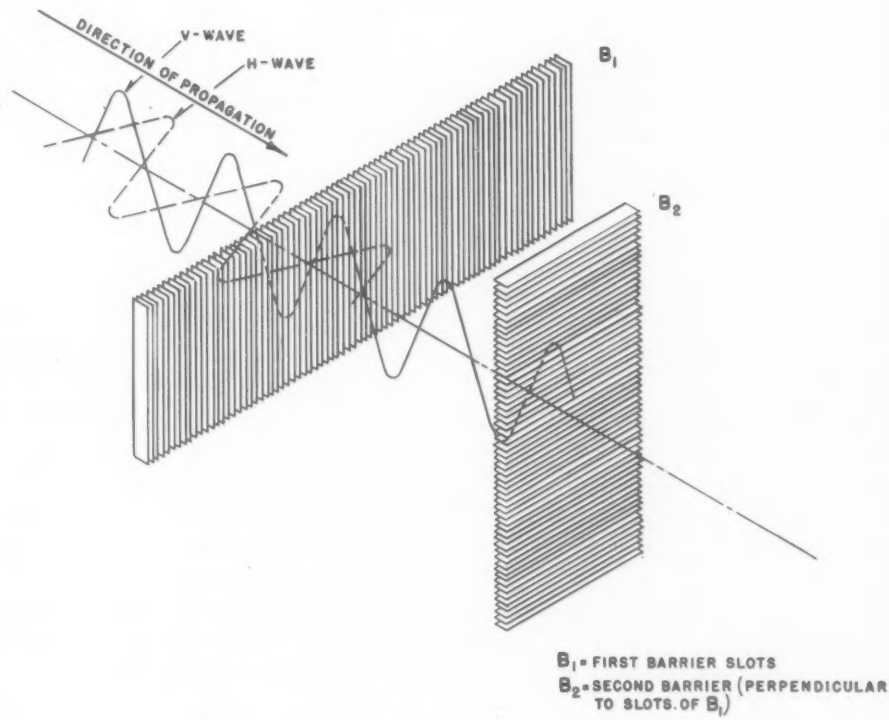


FIG. 4

tude is V_0, the amplitude, V, for any particular orientation, θ, will be

$$V = V_0 \cos \theta$$

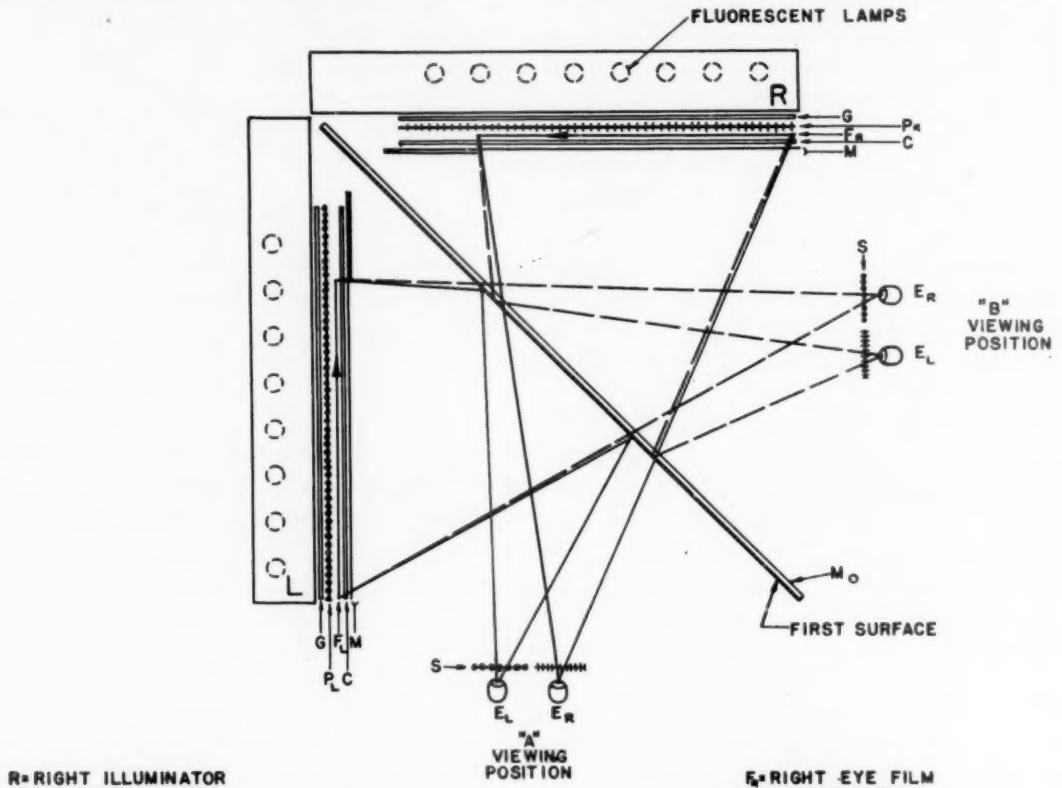
and the intensity of the transmitted ray will be

$$I_t = V_0^2 \cos^2 \theta$$

Two values of θ are of interest here. When $\theta = 0$, $V = V_0$ or complete transmission as mentioned above. When $\theta = 90°$, $V = 0$ or none of the radiation passing through the first barrier will emerge from the second (Fig. 4).

The same analysis can be applied to the original beam for extraction and ultimate extinction of the H-wave by rotating the first barrier through 90° in its own plane. The radiation emerging from the first barrier, H-wave only, is then said to be horizontally polarized. It will pass through a succeeding horizontal polarizer. It will be extinguished by a succeeding vertical polarizer.

Small polarizers have long been made by cementing together properly shaped pieces of crystal with the necessary optical properties—the Nicol prism, and with less efficiency by using a pile of thin glass plates. These have been costly as well as entirely too small for application in a stereoscope. The new Polaroid materials, employing a suspension of submicroscopic dichroic particles in sheet form, remove these difficulties. They polarize by simple transmission, resolving the two components of incident light, passing one and absorbing the other.



SCHEMATIC PLAN OF POLAROID STEREOSCOPE

FIG. 5

APPLICATION OF THE PRINCIPLE

It is now possible to state the principle upon which the new stereoscope is based: If two fields of polarized light are superimposed, one field with its axis of polarization at right angles to the axis of the other, the

fields may be resolved and viewed separately by means of two viewing polarizers set with their polarizing axes parallel to the respective fields. If, in particular, the one field is a left-eye stereoscopic roentgenogram and the other field is a right-eye stereoscopic roentgenogram, the two fields may be viewed simultaneously and separately by the left and right eyes of a number of observers provided only that the left and right eyes of the observers view the superposed fields through polarizing screens with their axes suitably oriented.

The Polaroid stereoscope is essentially a device employing polarizing screens and a semitransparent mirror for superposing two stereoscopic roentgenograms. In the device there are two lamp houses for illuminating the transparencies (roentgenograms); these are placed at right angles to each other. Each is fitted with a sheet of diffusing glass (Fig. 5) to provide uniform illumination over the whole film area, and on the viewing side is placed a screen—the *R*-illuminator screen is set to produce horizontally polarized light, the L-illuminator screen produces vertical polarization. A semitransparent mirror is placed midway between the two illuminators so that the illuminator system is symmetrical about the mirror.

To view the image the observer wears a pair of polarizing spectacles whose left lens is so positioned that it will transmit vertically polarized light from illuminator *L* by reflection from the mirror. This lens functions as the second system of optical slots and will obscure any light coming from the right illuminator by transmission through the mirror. The right lens is so positioned as to obscure the left illuminator but give the clear vision to the right illuminator.

The semitransparent mirror between the illuminators serves to make the unit compact and to superimpose the two images. By means of it, as seen in the diagram, the left eye sees the image before the left illuminator by reflection from the mirror; and the right eye sees the image before the right illuminator by transmission through the mirror. By using a mirror of equal reflection and transmission characteristics and a set of spectacles with properly oriented lenses, each eye sees only the image intended for it, and each with the same brightness. By consideration of the geometrical optics of the mirror position with respect to the two illuminated films, it is immediately clear that observation from any point in the region marked *A* will give the same results; and similarly for region *B*.

THE INSTRUMENT

The following will describe the component parts of the stereoscope and some of the effects experienced in viewing.

1. *Illuminating System.* Illumination is provided by a bank of eight fluorescent lamps in each lamp house so spaced that together with the sheet of diffusing glass placed over the viewing area there is a uniform distribution of light over the whole film area (18″×18″). By use of the fluorescent lamps, it has been possible to make considerable reduction in the size of the house, for the use of incandescent lamps would necessitate much more space to provide the same uniformity of illumination together with more heat to be dissipated. The power consumption for the whole stereoscope is only 240 watts (120 watts per illuminator) for approximately three times the illumination used in incandescent viewing boxes. This amount is necessary because of the losses inherent in the entire viewing system.

2. *Polarizers.* The polarizers consist of clear sheets of cellulose-acetate-base polaroid film sealed between a sheet of flashed opal diffusing glass and a thin sheet of clear plate glass. The diffusing surface is mounted nearer the lamps so that diffusion takes place before polarization. The clear glass serves to protect the polaroid sheet from abrasion and scratching by insertion of films, and the whole assembly holds the Polaroid sheet without subjecting it to any strain.

3. *Film Support and Transport.* A short distance before this Polaroid-glass pack is

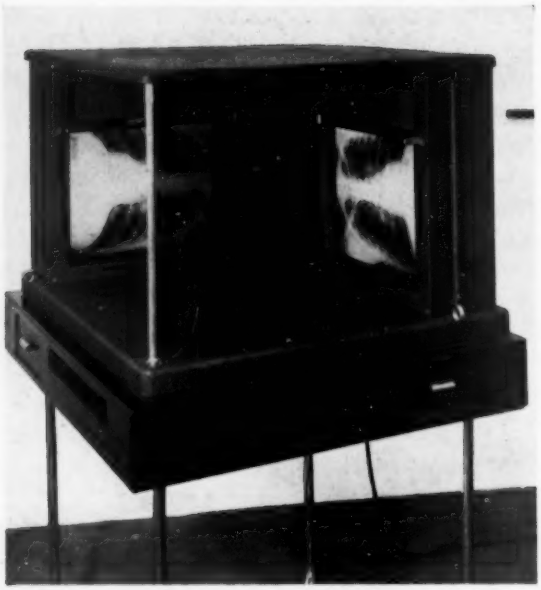


Fig. 6

another sheet of thin clear plate glass. Films are inserted at the side of the frame between this sheet and the Polaroid-glass pack. They rest on a track and are kept from bending by the support of the clear glass and the Polaroid-glass pack. They are then held entirely in view without the aid of springs or clips. A sliding clip actuated from the loading side serves to make slight adjustments in film positions in order to achieve effective superposition of the two images. This clip also functions as an ejector for removal of films.

4. *Mirror.* The semitransparent mirror is a sheet of plate glass free from defects upon which has been evaporated a uniform metallic film which has equal reflection, transmission, and absorption characteristics. The equality of these is essential so that each eye sees its image with equal brilliance. The metallic film is not unlike that used on the mirror surfaces in modern astronomical reflecting telescopes; it will not tarnish, and, though of necessity a delicate surface, is more durable than most reflecting surfaces. The glass thickness has been reduced to the minimum consistent with the strength required in an unsupported area of its size (20″×30″) in order to minimize the spurious effects arising from the thickness of the glass (see below).

5. *Masking.* In order to exclude the glare of the unused illuminator area when the film size is less than 18″×18″, masking provisions have been made in the form of a set of two opaque shades for each film. These shades operate in a plane immediately before the film supporting region and are easily and conveniently adjustable.

6. *Viewing Effects.* (a) *Superposition.* To receive the sensation of three-dimensional vision the two films are inserted into their proper illuminator boxes. For most comfortable viewing the two films are then moved until, when examined without the aid of spectacles, the edges of one film appear to coincide with those of the other. This will usually produce an effective superposition of the gross outlines on the two films. To remove the glare from the area surrounding the films, the masking shades are then drawn until they just cover the edges of the films and their edges appear to coincide. Now inspection with the spectacles will produce the stereoscopic view.

(b) *Off-Superposition.* In general when two picture records are made of a particular object-space each from a different viewpoint and each made on a different piece of film, it would be possible to have to make four adjustments in setting them up for viewing, for compensation would have to be made for the possible position errors in exact replacement of the first film by the second. The second film may have failed to occupy the original position by (1) a shift parallel to the its length; (2) a shift parallel to the its width; (3) a rotational shift so that the sides were no longer parallel to the original film position; (4) a shift in distance from the object space, by any combination of these four possibilities.

From these considerations it would seem necessary to provide means of compensation for all eventualities. This, fortunately, is not necessary since devices made for the transport and replacement of films in stereoscopic work are so designed that the third and fourth possibilities cannot occur

and so that either the first or the second is non-existent (dependent on the position of cassette in the holder). The remaining possible failure in exact replacement is minimized in most equipment by proper design of the mechanical systems.

In the viewing system the two film transport systems are so arranged that the lower edges of the films lie on the same plane normal to their faces and to the mirror so that they are brought automatically into superposition in the vertical direction. The transport device, as well as introducing and ejecting the films, serves to move the films horizontally to make whatever small corrections are necessary for proper effective superposition of the two images (i.e., compensation necessary for the errors introduced through (1) or (2) above).

Concerning the relative importance of the failures in exact superposition of the two films, it is interesting to point out for 14″×17″ films in viewing one film may be shifted parallel to the other vertically by $\pm\frac{1}{2}$ inch from the superposition before the eyes of an accustomed observer experience serious discomfort and fatigue and refuse to coordinate the two views. In the case of horizontal displacement as much as ± 2 inches from true superposition is possible. Accompanying this greater shift is the phenomenon of apparent change in scale of the reproduction of the object-space. When the shift is such that one picture has been shifted from superposition toward the inner corner of the system, the other remaining fixed, the eyes experience a converging influence similar to that felt in examining something at close range, and a similar sensation is received—the apparent object-space scale is increased and one appears to be viewing the object-space at closer range. Similarly if the shift is in the opposite direction (toward the outer edge of the illuminator) the eyes diverge from normal position and the effect produced is that of viewing at a distance.

These variations from superposition are mentioned only to show the degree to which errors may be made in positioning the films for viewing and the attendant effects. Great deviation from superposition is undesirable because of the undue strain it places on the eyes. As seen above, vertical shifts are more serious than horizontal shifts and provisions have been made to minimize the possibility of there being a sizable misplacement of films in this position. The horizontal shift is less serious and is completely under control of the observer by the film transport mechanism.

Fig. 7

(c) A semitransparent mirror is used to effect the superposition of the films. Since the reflecting surface must be supported by a transparent base of a thickness to provide adequate strength, one side will be a first-surface mirror giving clear undistorted definition by reflection and equally clear vision by transmission. In viewing from the other side of the stereoscope without the aid of Polaroid spectacles the *R* film is seen by reflection in a clearly defined image with a faint secondary image slightly displaced from it by an amount depending on the point of observation. The intensity of this secondary image is very low and, when observed through the Polaroid spectacles, is found to be so faint as to be of small

consequence and not to interfere with the recreation of the original three-dimensional object.

(d) Since this stereoscope depends for its action upon the mutual perpendicularity of the various Polaroid elements, it is impossible to see clearly the stereoscopic image if the spectacles are thrown out of their proper position by tilting the head. Observers have no difficulty in retaining the proper position, for once it has been found reflex action seems to prevent a departure.

(e) *Spectacles*. Viewing is accomplished by observation through spectacles with Polaroid lenses. In this stereoscope, the two films are arranged with similar ends adjacent to the inner corner so that reflection from the mirror will superimpose them. Thus, when viewing from the *B*-side, the images both transmitted and reflected will be left to right mirror images of those scenes from the *A*-side. Because of this mirror reversal, if the observer moves to the *B*-side and retains the same spectacles used for viewing from the *A*-side, he will see a pseudostereoscopic effect in which the depth relations in the reconstructed object space are a reversal of the original space arrangement; that is, he will be viewing the object-space from a position behind it rather than from before it. This illusion is possible also with the Wheatstone stereoscope when the films have been improperly set up so that the right eye sees the normal left eye image, and vice versa.

In this new stereoscope, this effect is rectified by providing separate spectacles having their lenses reversed in orientation. It has been found convenient to mark the spectacles clearly to indicate for which side of the stereoscope they are to be used. In this way it is possible for all of those grouped about the stereoscope to receive the same sensation in viewing the reconstructed object-space.

The Polaroid stereoscope has been constructed for images as large as 18 inches square so that it will accommodate all standard sizes of roentgenograms. Because of the small amount of individual observation equipment and the small expense involved in providing a sufficient number of spectacles, the problem of simultaneously presenting stereoscopic images to all members of a group is satisfactorily solved. The number of observers that can be accommodated is determined mainly by considerations of comfort and convenience; without undue crowding, eight persons may inspect the images at once, four on the *A*-side and four on the *B*-side.

REFERENCES

1–5. Patents No. 1,918,484; 1,951,664; 1,956,867; 2,005,426; 2,011,553; 2,078,254.
6. LAND, E. H. *J. Franklin Inst.*, Sept., 1937, *224*.
7. Patent No. 2,084,350.

Vol. 45, No. 5

BIOPHOTOMETRIC MEASUREMENTS OF DARK ADAPTATION AMONG ROENTGENOLOGISTS

A MEASURE OF VITAMIN A DEFICIENCY

By HENRY H. LERNER, B.S., M.D.
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THE ability to discern details on passing from a well lighted room into a dark one, known as "dark adaptation" is a phenomenon which has recently been linked up with the presence of a sufficient supply of vitamin A in the body.[1,3,4,6] It has also been shown that approximately 20 per cent of all children,[4] and from 10 to 50 per cent of adults,[5,6,7,9] have clinical or subclinical degrees of vitamin A deficiency.

Vision under faint illumination depends upon the metabolism of visual purple in the retinal rod cells of the eye. The precursor of visual purple is now known to be vitamin A.[2,10] When the eye is exposed to light, the visual purple becomes exhausted. In the presence of an adequate supply of vitamin A, the visual purple regenerates, and dark adaptation is normal. A poor supply of vitamin A manifests itself by the inability to accommodate rapidly in faint illumination or in darkness, known as hemeralopia, or "night blindness."[2,10] Constant or frequent exposures to bright light, such as is encountered in using roentgen-ray viewing boxes, exhaust the supply of visual purple and result in a lowered acuity of vision under faint illumination.

To the roentgenologist who spends considerable time in a room that is faintly illuminated, knowledge as to whether or not he has a vitamin A deficiency is therefore important. It has been my experience that the answers to the question, "What is the optimum or minimum time the eyes should be accommodated before roentgenoscoping?" vary widely from one to twenty minutes. That such wide variations in the ability to accommodate do exist is well known. If these variations are in some measure due to a relative vitamin A deficiency, the implication is obvious. It is this point with which we are concerned.

In the experiment outlined, 16 subjects were used. All of them are associated with the roentgenological departments of hospitals in Boston. The factor of training and familiarity of working in the dark was recognized, but, if anything, should have tended to improve the individuals' score. The tests were done early in the morning. This point is worthy of note in determining the best time of the day to do roentgenoscopy (Chart II).

The technique of the test has been described in detail by Jeans, *et al.*[3] Essentially, it consists of measuring with a biophotometer the ability to see varying degrees of faint illumination (expressed in millifoot-candles) following accommodation in the dark for ten minutes, and then after exposure for three minutes to a bright light. During the following ten minutes, the patient is in the dark, and readings are taken every two and one-half minutes. The data thus obtained are plotted on a graph giving a curve which shows: first, a preliminary period of adaptation (first rise), followed by the depletion of visual purple by a bright light (descending line); second, the regeneration in the dark, shown by the rise in accommodating power (ascending line), of visual purple from vitamin A, or dark adaptation. This curve thus indicates the status of the individual as to vitamin A content of the body.

A normal curve (Chart I) was found in 12 of the subjects. These curves started at a fairly high level and after exposure to bright light dropped sharply, but never below 0.6 millifoot-candles, to be followed by a rapid rise, almost back to the base line, in five minutes.

In 4 of the subjects, subnormal curves showing vitamin A deficiency were obtained with a drop below 0.6 millifoot-

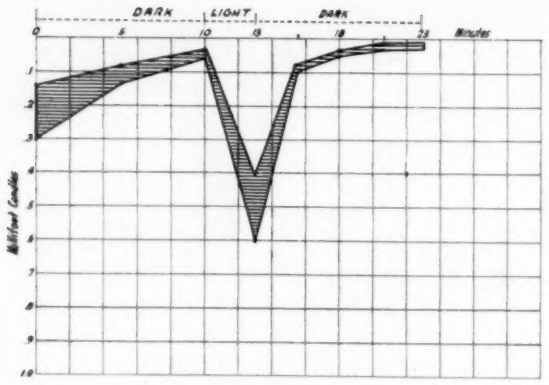

CHART I. Range of twelve normals.

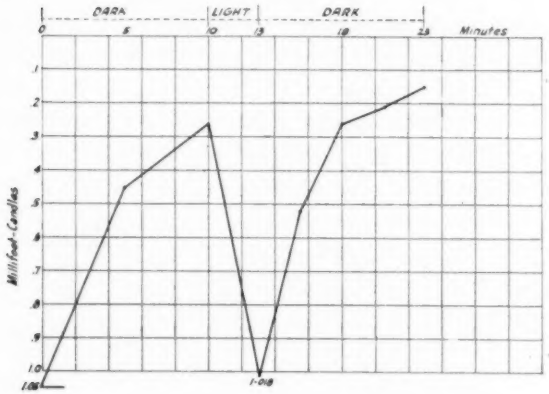

CHART II. Test done about one hour after subject had been reading roentgenograms. Shows exhaustion of visual purple resulting in a prolonged accommodation and failure to reach normal.

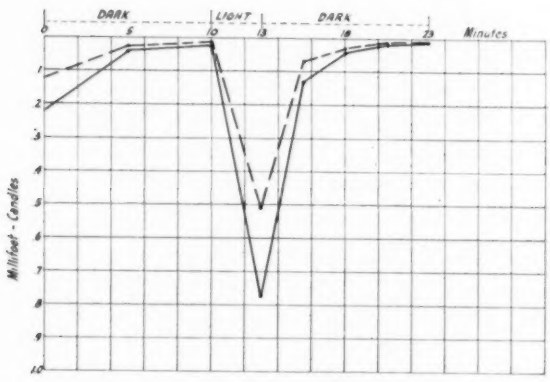

CHART III.——vitamin A deficiency; — — — after improvement of diet, normal.

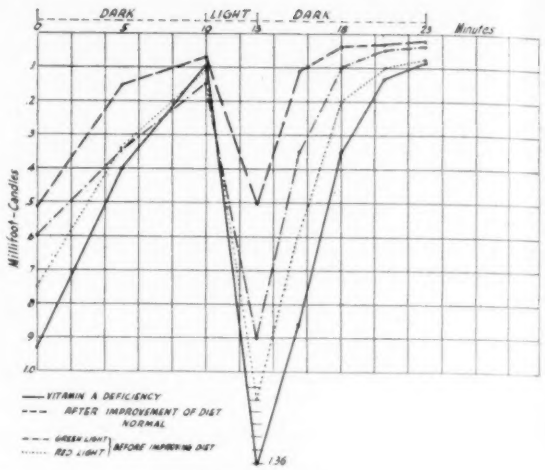

CHART IV

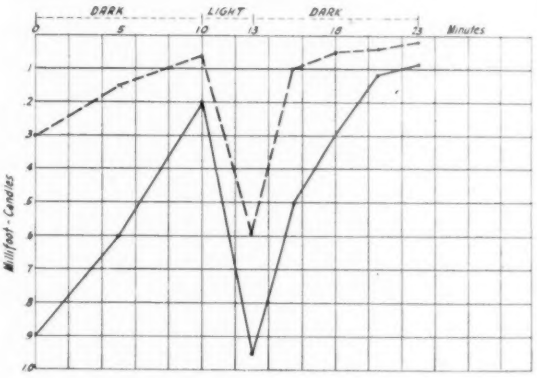

CHART V.——vitamin A deficiency; — — — after improvement of diet, normal.

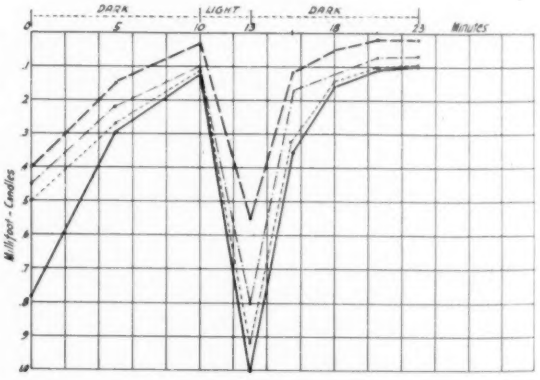

CHART VI.——vitamin A deficiency; — — — after improvement of diet, normal; —·—· green light, ---------- red light, before improving diet.

candles, and a delayed rise back to the base line. Of this group (Charts V and VI) 2 admitted they had noticed considerable difficulty in night driving (as has been reported by others). Another (Chart IV) stated he had been conscious that it took him longer to accommodate in the darkness than it did his associates. Peculiarly enough, this

subject admitted an adversion to dairy products and vegetables, which he omitted in his diet, resulting in a low vitamin A intake. The fourth (Chart III) stated she always found it difficult to get to her seat in a darkened theater.

These 4 subjects were then put on a high vitamin A diet plus carotene (30,000 units daily). This was followed by a rapid subjective improvement of symptoms, and an objective return to a normal biophotometer reading in three weeks (Charts III, IV, V and VI).

On the basis of the extensive work done by others,[1,3,4,6] and the finding, in this experiment, of vitamin A deficiency in 25 per cent of those whose work entails considerable time spent under faint illumination, it is suggested that all roentgenologists avail themselves of a visual acuity test in dim illumination.

If this cannot be done, the empirical increase in diet of foods high in vitamin A is desirable if the roentgenologist wishes to get the most out of his roentgenoscopy, and to minimize the time spent in accommodating his eyes before roentgenoscoping.

It is likewise suggested that from three to five minutes is the optimum time the normal individual should spend in accommodation before roentgenoscoping. The increase in acuity after five minutes being so slight, it is felt that a longer time is not necessary.

As a corollary to the main thesis of this paper, an attempt was made to determine by this method what type of colored dim illumination was preferable in the roentgenoscopic room. In the hospitals where the experiment was carried on, two different colors, red and green, were used. In this part of the experiment the test was carried on as in the previous part, with the exception that the room was illuminated by a 5 watt bulb in front of which either a red or green glass "bull's eye" could be fastened. Throughout the experiment, the illumination was constant. Curves for adaptation were then obtained under red and green illumination.

In normals, these curves followed the same course as those for adaptation in total darkness. There was a slight tendency shown to accommodate more rapidly in green light than in red, indicating that green is the preferable color to use for dim illumination of the roentgenoscopic room.

Two of the curves in the subnormal subjects (Charts IV and VI) were interesting in that their adaptation did not drop as low and came back more rapidly under red and green illumination than in total darkness. The explanation for this is felt to lie in the fact that colored light is a stimulus for regeneration of visual purple.

Further work on dark adaptation under faint colored illumination with a larger group of vitamin A deficient individuals is now in progress.

REFERENCES

1. Frandsen, H. Hemeralopia as an early criterion of A-avitaminosis and clinical symptoms and treatment of this disease. *Acta ophth.*, supp. 4, 1935, pp. 1–160.
2. Fridericia, L. S., and Holm, E. Experimental contribution to the study of the relation between night blindness and malnutrition; influence of deficiency of fat-soluble A vitamin in diet on visual purple in eyes of rats. *Am. J. Physiol.*, 1925, *73*, 63–78.
3. Jeans, P. C., Blanchard, E., and Zentmire, Zelma. Dark adaptation and vitamin A; new photometric technic. *J. Am. M. Ass.*, 1937, *108*, 451–458.
4. Jeans, P. C., and Zentmire, Zelma. Clinical method for determining moderate degrees of vitamin A deficiency. *J. Am. M. Ass.*, 1934, *102*, 892–895.
5. Jeans, P. C., and Zentmire, Zelma. Prevalence of vitamin A deficiency among Iowa childen. *J. Am. M. Ass.*, 1936, *106*, 996–997.
6. Jeghers, H. Night blindness due to vitamin A deficiency; consideration of its importance in traffic problems. *New England J. Med.*, 1937, *216*, 51–56.
7. Park, I. O. Preliminary observations on vitamin A deficiency as shown by studies with visual photometer. *J. Oklahoma M. Ass.*, 1935, *28*, 357–364.
8. Park, I. O. Further observations on vitamin A deficiency as shown by studies with visual photometer and clinically. *J. Oklahoma M. Ass.*, 1936, *29*, 129–141.
9. Sandler, A. S. Carotene in prophylactic pediatrics. *Arch. Pediat.*, 1935, *52*, 391–406.
10. Tansley, K. Regeneration of visual purple; its relation to dark adaptation and night blindness. *J. Physiol.*, 1931, *71*, 442–458.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Twenty-sixth Annual Meeting: Hotel Cleveland, Cleveland, Ohio, June 2–3, 1941.

EDITORIAL

SERUM AND TISSUE PHOSPHATASE DETERMINATIONS IN RADIATION THERAPY

FOR A NUMBER of years phosphatase determinations have been made on the serum of patients suffering from bone dyscrasias in one form or another. In the last few years considerable has been added to our knowledge of phosphatase determinations, particularly in malignant diseases.

Woodard and Higinbotham,[1] in a rather critical study of the subject in 1937, called attention to the correlation between serum phosphatase and roentgenographic type in bone diseases. From their studies they believed that certain conclusions might be drawn, namely, that if a high serum phosphatase is found associated with an osteoplastic lesion or a normal serum phosphatase with an osteolytic lesion then the phosphatase determination has served only to confirm the diagnosis made by the roentgenogram. If a normal serum phosphatase is found associated with an osteoplastic lesion then the process is probably slow growing and relatively benign. If, on the other hand, a high serum phosphatase is found associated with an osteolytic lesion the authors believe that several possibilities present themselves: namely, the case may be one of hyperparathyroidism or there may be an osteoplastic disease elsewhere in the body which will account for the high serum phosphatase even though the presenting lesion is osteolytic; or the case may be one of the group made up chiefly of endotheliomas or carcinomas of diverse origin, metastatic to bone, which raise the serum phosphatase level but for some unknown reason do not form new bone; or the case may be an early, highly malignant osteogenic sarcoma. They also arrived at the conclusion that determinations of serum phosphatase in cases of bone tumors which have been treated by roentgen or gamma rays are useful in indicating the degree and permanence of the inactivation caused by the irradiation.

Following up these studies Woodard and Higinbotham have quite recently called attention to serum and tissue phosphatase determinations as an aid in evaluating the radiation therapy of bone tumors.[2] Heretofore the effect of irradiation could only be determined by the degree of symptomatic relief, by variations in the size of the tumor and particularly by the changes in the roentgenographic appearance of the malignant process.

The authors were particularly impressed in their clinical study of the large number of patients upon whom estimations of tissue and serum phosphatase were done in finding the close correlation of the phosphatase values with the clinical pictures. Previous work which they and others had done made it evident that the excess phosphatase which appears in the serum of many patients with bone tumors originates in the tumors and that the decrease in serum phosphatase following radiation therapy or surgical extirpation is due to inactivation or removal of the tumor, and that when irradiation of the tumor is followed by a fall in the serum phosphatase the fall is due to inactivation of the phosphatase-forming mechanism of the tumor.

Woodard and Higinbotham call attention to the fact that the excess phosphatase

[1] Woodard, Helen Q., and Higinbotham, Norman L. The correlation between serum phosphatase and roentgenographic type in bone disease. *Am. J. Cancer*, 1937, *31*, 221–237.

[2] Woodard, Helen Q., and Higinbotham, Norman L. Serum and tissue phosphatase determinations as an aid in evaluating the radiation therapy of bone tumors. *J. Am. M. Ass.*, April 12, 1941, *116*, 1621–1627.

in the serum of patients with primary bone tumors comes from the tumor and when the source is removed or inactivated the serum phosphatase level falls to normal within one or two weeks. They point out with considerable clarity the difference in the situation when cancer originates in a soft part and metastasizes to bone. The serum phosphatase brought about by such a mechanism is produced not by the invading tumor but as part of a defense healing reaction in the adjacent bone and this accounts for only the slight changes in the serum phosphatase seen in cases of carcinoma of the breast or thyroid which elicits little defense in bone reaction, being of an osteolytic nature.

There is a striking difference, however, in carcinoma of the prostate which usually causes an intense osteoplastic reaction with pronounced elevation of the serum phosphatase level. Why this response of the bone to invasion by different tissues varies so greatly in intensity is a problem which Woodard and Higinbotham point out needs further study.

This problem of response to bone invasion by different metastatic tumors was attacked by Downs and Hastings[3] and from their observations they were led to postulate the theory that if the primary tumor has the stimulus within itself to cause the growth of young connective tissue, whatever the nature of that stimulus may prove to be, then its cells when they metastasize in bone will exercise the same stimulus, producing osteoplastic change; conversely, highly cellular tumors without the power of exciting desmoplasia produce osteolytic metastases, and they raise the query as to whether it is not rational to reason that since fibroblasts and osteoblasts are so closely akin their relation to a given stimulus would be quite similar. This highly suggestive work of Downs and Hastings on the types of metastatic carcinoma of bone warrants further investigation.

[3] Downs, E. E., and Hastings, W. S. Factors influencing the types of metastatic carcinoma of bone. Am. J. Roentgenol. & Rad. Therapy, 1933, *29*, 1–7.

From the work of Woodard and Higinbotham it is evident that irradiation of a metastatic lesion of bone may affect production of phosphatase directly by inactivating the defense mechanism or indirectly by inactivating the tumor which is eliciting the defense reaction. The authors have not, however, observed changes indicating that irradiation ever stimulates the defense mechanism. They believe that when the tumor is inactivated by radiation therapy and the defense mechanism is relatively unaffected the serum phosphatase level remains high until repair is well advanced.

Serum phosphatase determinations are a reliable indication of the results of roentgen therapy of metastases to bone only when sufficient time has elapsed for healing to take place. In the experience of Woodard and Higinbotham, if a patient with metastatic disease of bone accompanied by a high serum phosphatase level is treated and the serum phosphatase level fails to fall to normal within three months either the treatment has been inadequate or new lesions are developing. In one type of metastatic disease, namely, carcinoma of the prostate with involvement of bone, it is possible to follow the activity of both the metastatic tumor and the surrounding bone by means of serum phosphatase determinations.

It is well known that the phosphatase of bone has its maximum activity in alkaline solutions but both normal and cancerous prostatic tissue contain a phosphatase which is active in acid solutions but almost completely negative in the alkaline range. It has been shown that osseous tissue invaded by prostatic metastases contains both acid and alkaline phosphatase and that both enzymes escape readily into the circulation. One example is cited of the usefulness of determinations of both acid and alkaline phosphatase of the serum in the presence of carcinoma of the prostate which has metastasized to bone.

Woodard and Higinbotham found that the phosphatase producing mechanism of

most of the tumors is inactivated by radiation therapy when the tissue dose equals or exceeds 4,000 roentgens and that smaller doses cause only irregular or incomplete inactivation. In patients suffering from osteogenic sarcoma, elevated serum phosphatase values or changes in phosphatase afford a prompt indication of the effect of radiation therapy.

During the course of their researches they were able to study in one case the activity of various portions of the tumor by the use of radioactive phosphorus. It was noted that radioactive phosphorus given by mouth localized in the portions of tissue of osteogenic sarcoma which contained the most phosphatase.

These studies of Woodard and Higinbotham are of great importance not only in their practical application but in opening up new avenues of attack in the problem of neoplastic disease.

[4] Wolfson, S. A., Reznick, S., and Gunther, L. Early diagnosis of malignant metastases to the spine. *J. Am. M. Ass.*, March 15, 1941, *116*, 1044–1048.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. C. B. Peirce, Royal Victoria Hospital, Montreal, Canada. Annual Meeting: Cincinnati, Ohio, Sept. 23–26, 1941.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Annual meeting: Hotel Statler, Cleveland, June 4, 1941.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Cleveland, Ohio, June 2–6, 1941.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting, 1941: To be announced.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. Wilbur Bailey, 2007 Wilshire Blvd., Los Angeles. Next annual session, Hotel Del Monte, Del Monte, May 5–8, 1941.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES CO. MED. SOC.
Secretary, Dr. Wilbur Bailey, 2007 Wilshire Blvd., Los Angeles, Calif. Meets on second Wednesday of each month at County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. L. J. Taormina, 1093 Gates Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. C. J. Challenger, 3117 Logan Blvd. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. H. A. Mahrer, 10515 Carnegie Ave. Meets at 6:30 P.M. at Mid-Day Club rooms on fourth Monday each month, October to April, inclusive.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. P. R. Weeks, 520 Republic Bldg., Denver, Colo. Meets third Friday of each month.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. J. N. Moore, 210 Professional Bldg., Ocala, Florida. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. R. C. Pendergrass, Prather Clinic Bldg., Americus, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meetings held quarterly, on the fourth Sunday of the month.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. C. C. Taylor, 23 E. Ohio St., Indianapolis, Ind. Meeting held the second Sunday in May annually.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. J. C. Bell, 402 Heyburn Bldg., Louisville. Meets annually in Louisville on third Sunday afternoon in April.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. J. E. Lofstrom, 1536 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. I. I. Cowan, Mt. Sinai Hospital, Milwaukee, Wis. Meets monthly on first Friday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. J. P. Medelman, 572 Lowry Medical Arts Bldg., St. Paul.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. A. O. Hampton, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. W. J. Marquis, 198 Clinton Ave., Newark. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. E. J. Ryan, St. Luke's Hospital, New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

PACIFIC ROENTGEN SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport Pa. Next annual meeting, William Penn Hotel, Pittsburgh, Pa., May 16–17, 1941.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. B. R. Young, Temple University Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. H. W. Jacox, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. S. C. Davidson, 277 Alexander St. Meets on second Thursday from October to May, inclusive, 8 P.M., Rochester Academy of Medicine Building.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

St. Louis Society of Radiologists
Secretary, Dr. W. K. Mueller, University Club Bldg. Meets fourth Wednesday of October, January, March and May, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. H. A. Hill, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 p.m., first six months at Toland Hall, second at Lane Hall.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. L. W. Baird, Scott and White Hospital, Temple, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 p.m. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 p.m., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. C. H. Peterson, 603 Medical Arts Bldg., Roanoke, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. K. J. Holtz, American Bank Bldg., Seattle. Meets fourth Monday of each month at the College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets monthly on third Thursday from November to June inclusive, at 8:15 p.m., 32 Welbeck St., London.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:15 p.m. at the Royal Society of Medicine, 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1, England.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive for scientific discussion.

Canadian Association of Radiologists
Secretary, Dr. A. C. Singleton, Medical Arts Bldg. Toronto, 5, Ontario.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext., Halifax, N.S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium). Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Saine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel. Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Saine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, II.52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aertze.
Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Süd- und Westdeutsche Röntgengesellschaft
Meets annually in different cities.

Nord- und Ostdeutsche Röntgengesellschaft
Meets annually in different cities.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the spring, and one in the fall.

Societa Italiana Radiologia Medica
Secretary, M. Ponzio, University of Turin, Prof. Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly on first Monday at 8 o'clock.

Scandinavian Roentgen Socieities
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

Society of Medical Radiology in Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. G. Biering, Copenhagen. Meets the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Roentgen Society
Meets first Wednesday of each month, at 6:30 p.m. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

Orient

Japan X-Ray Association
c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto, Japan. Meets bi-monthly on third Sunday.

AMERICAN RADIUM SOCIETY

The Twenty-sixth Annual Meeting of the American Radium Society will be held in Cleveland, Ohio, in the Red Room of the Hotel Cleveland, on Monday and Tuesday, June 2 and 3, 1941. The following program has been arranged:

PROGRAM

Monday Morning, June 2, 1941

8:30 A.M. Executive Session.

9:00 A.M. Scientific Session.

Presidential Address. Frederick W. O'Brien, M.D., Boston.

The Treatment of Cancer of the Skin of the Nose. G. Allen Robinson, M.D., and John H. Harris, M.D., New York.

The Treatment of Cancer of the Skin of the Ear. James R. Driver, M.D., and Harold N. Cole, M.D., Cleveland, Ohio.

Deep Tissue Reactions Following Irradiation for Cancer of the Upper Respiratory Tract. Howard H. Ashbury, M.D., Baltimore.

Five-Year End-Results in Intrinsic and Extrinsic Laryngeal Cancer. John V. Blady, M.D., and W. Edward Chamberlain, M.D. Philadelphia.

Cancer of the Nasopharynx. Maurice Lenz, M.D., Arthur P. Stout, M.D., and Haig H. Kasabach, M.D., New York.

Monday Afternoon, June 2, 1941

2:00 P.M. Executive Session.

2:20 P.M. Scientific Session.

Fibrosis of the Lung Following Roentgen Irradiation for Breast Cancer: A Clinical Study. J. E. Leach, M.D., J. H. Farrow, M.D., F. W. Foote, Jr., M.D., and N. W. Wawro, M.D., New York.

The Inadequacy of Local or Incomplete Mastectomy in the Treatment of Breast Cancer. J. W. Bransfield, M.D., and S. G. Castigliano, M.D., Philadelphia.

4:00 P.M. Janeway Lecture

The Philosophy and Economics of Cancer. Edward H. Skinner, M.D., Kansas City, Missouri.

Monday Evening, June 2, 1941

ANNUAL DINNER

Seven O'clock

Red Room, Hotel Cleveland

Tuesday Morning, June 3, 1941

8:30 A.M. Executive Session.

9:00 A.M. Scientific Session.

Contact Therapy. Evaluation of Results from a Clinical and Pathological Standpoint. William E. Howes, M.D., and Mortimer R. Camiel, M.D., Brooklyn.

The Layer Technique in Radium Needle Therapy. Charles L. Martin, M.D., Dallas, Texas.

Pathologic Aspects of Radiosensitivity of Malignant Tumors. Shields Warren, M.D., Boston.

The Tumor Response to X-ray as Influenced by the Host-Tumor Relationship. A. W. Oughterson, M.D., New Haven, Conn.

Dosage Determinations with Radioactive Isotopes. L. D. Marinelli, New York.

The Treatment of Lymphosarcoma with Radioactive Phosphorus. John M. Kenney, M.D., L. D. Marinelli, and Lloyd F. Craver, M.D., New York.

The Relation of Phosphatase Activity in Bone Tumors to the Deposition of Radioactive Phosphorus. Helen Q. Woodard, Ph.D., and John M. Kenney, M.D., New York.

Tuesday Afternoon, June 3, 1941

2:00 P.M. Executive Session.

2:20 P.M. Scientific Session.

Radium Treatment of Cancer of the Bladder: Report of 267 Cases. Charles C. Herger, M.D., and Hans R. Sauer, M.D., Buffalo.

Cancer of the Rectum and Sigmoid in the Aged. William T. Shedden, M.D., Boston.

The Effects of Preoperative Irradiation in the Treatment of Bone Sarcoma. Bradley L. Coley, M.D., and Norman L. Higinbotham, M.D., New York.

End-Results in Cancer of the Ovary from 1910–1935 at the Roosevelt Hospital. Howard C. Taylor, Jr., and Arthur V. Greeley, M.D., New York.

Further Studies of Radium Treatment for Cancer of the Uterine Fundus. Robert E. Fricke, M.D., and Harry H. Bowing, M.D., Rochester, Minnesota.

Pneumoperitoneum as an Aid in Pelvic Irradiation. Leroy R. Sante, M.D., St. Louis, Missouri.

Interstitial Irradiation in Cancer of the Uterine Cervix. J. Robert Andrews, Cleveland.

BULLETIN OF THE INTER-SOCIETY COMMITTEE FOR RADIOLOGY

The following communications were sent to State Councilors of the American College of Radiology and secretaries of all regional radiological societies on March 21, 1941:

NATIONAL YOUTH ADMINISTRATION HEALTH PROGRAM

In connection with what is apparently a rather hastily prepared "health program," the National Youth Administration proposes to provide a physical examination for some 500,000 youths between the ages of 17 and 24 enrolled in the NYA program during the coming year.

The examination will include, in some localities, a routine roentgen examination of the chest. In others, roentgen examinations will be performed on positive tuberculin reactors. Regulations provide that, "Chest X-rays of NYA youth should be undertaken only where an experienced roentgenologist is available."

One of the expressed aims of the NYA health program is to develop "in youth an interest in improving their health by their own personal efforts." It has been indicated that existing health and medical facilities are to be used. Consistent with these principles, youths should be taught in connection with the project that medical service should be sought from private physicians instead of governmental agencies or free clinics. We suggest, therefore, that agreements be made with the director in each state to have youths referred to private radiologists in their offices or hospitals for examination.

Each state health program will be directed by an appointed physician who will be assisted by a full-time supervisor. The method for remuneration of radiologists participating in the project is a matter for negotiation between the radiological organization in each state and the director.

In response to an inquiry from this office, we have received the following advice in a letter from Dr. C. E. Rice, Director of Health of the NYA in Washington:

> The State-wide health program is operated as a project with the State health department of the particular State acting as co-sponsor. Under this arrangement the health department contributes services which may be available. In many instances, there is a State mobile chest clinic which will assist in securing chest x-rays. In some instances chest plates may be secured through a local tuberculosis association where the association is operating a chest clinic. In either instance NYA can furnish the necessary films, but it is expected that because of a common interest in tuberculosis control, the remainder of the cost would be borne by the cooperating agency.
>
> As indicated in the Health Manual and referred to in your letter, NYA cannot obtain services on a contractual basis. This is because of certain legal limitations placed on expenditure of funds. However, services of physicians and specialists may be secured on a per diem basis, which is usually reduced to an hourly rate. The rate per hour for examining physicians; roentgenologists may be reimbursed for service in the same manner, with NYA furnishing the x-ray films and chemicals for developing and fixing the plates.
>
> Because of limitation in funds available for the health program, the States have been asked to keep the average expense of examination, including immunization and laboratory work, below $3.50 per youth. To keep within this figure NYA will necessarily depend to some extent on the contribution of services from official and voluntary agencies as well as from individuals.

This means that the NYA will furnish films but funds for remuneration of radiologists must be obtained from some "cooperating agency." Presumably this would be the local or state tuberculosis association or health department.

At its meeting last month the Board of Chancellors of the College adopted a motion to the effect that, since other examining physicians are to be compensated for their services, radiologists should not be expected to contribute their services at a loss in connection with the NYA health program.

We suggest the following procedure for the consideration of radiologists in your state:

1. Confer with the state health director of NYA, with an offer on the part of radiologists to cooperate to the fullest extent.
2. Arrange for roentgen examination to be done by private physicians instead of governmental agencies or eleemosynary institutions in accordance with the aim to educate the youths in good health practices and citizenship. Provide the director with a list of qualified radiologists willing to participate.
3. Agree upon an hourly rate for compensa-

tion of radiologists, and a method for computing hours consumed. Radiologists might keep a record of time devoted to examination of youths referred by NYA, or the total time might be computed according to an agreed period per examination.

4. Arrange for the distribution to participating radiologists of a supply of films purchased by NYA, the unused balance to be returned.
5. Agree upon a specified hour each day or a specified day each week, during which NYA youths would be accepted for examination. Unless someone is prepared to pay full fees for this work, radiologists should not be expected to neglect private patients in performing a service of a charitable nature.

Cooperation of the medical profession is essential if the NYA health program is to succeed. There seems to be no reason why radiologists should accept an arrangement that is not completely fair.

SELECTIVE SERVICE EXAMINATIONS

The following memorandum pertaining to Selective Service Examinations is submitted for your attention.

When the volume of service demanded of radiologists in connection with the examination of draftees is proving burdensome, two suggestions have been offered:

1. Medical Advisory Boards in each community may be provided with a list of qualified radiologists in that area. Requests for roentgen examination might be rotated among the radiologists listed, or the Selective Service registrant referred for examination might be permitted to choose his radiologist from the list available.

2. Arrangements might be made with the various Medical Advisory Boards by which radiologists could choose the time when they will perform this charitable and patriotic service. A specified hour each day, during which Selective Service registrants could be examined with a minimum of interruption in their private practice, might be agreed upon among all participating radiologists. Registrants referred for roentgen examination would then be advised by the Medical Advisory Board that they must present themselves during the appointed hour to a specified radiologist or the one of their choice, according to which system is used for distributing this work.

MEMORANDUM

The following are excerpts from the Minutes of the meeting of the Board of Chancellors of the American College of Radiology, February 17, 1941.

A special reference committee appointed by the Chairman, and composed of Dr. E. P. Pendergrass, Dr. L. H. Garland, and Dr. E. W. Rowe, submitted the following report, which, upon a motion duly made and passed, was adopted:

Several Members and Fellows of the American College of Radiology have requested advice as to procedure and recovery of costs in connection with Selective Service Examinations. The Board of Chancellors of the College believes that as far as procedure is concerned, the following applies to the greater part of the country at the present time:

Selective Service candidates or draftees are examined by local draft boards. Physicians on these draft boards who desire to have a draftee examined radiologically may refer the candidate directly to the radiologist who is on his local Advisory Board or may refer him to the Director of that Board for permission for x-ray examination; in some instances he may utilize such other radiological facilities as are provided. X-ray reports are sent directly to the referring physician and the films are retained by the radiologist or at the source where they are made.

The radiologist sends a statement for material costs incurred to the State Procurement Officer at the end of each month. Such statements must be countersigned by the Chief of the Medical Advisory Board and contain two certificates recording the fact that the fee charged is "not in excess of that charged other patients," and that the fee for professional and non-material costs is waived.

The question of material costs schedule was considered by the Board of Chancellors. Correspondence reveals that many different schedules are in effect throughout the country at the present time. The Board is sympathetic with those physicians who believe that the Government should be expected to pay for medical services just as its pays for other professional and business services.

However, as long as the official policy of the American Medical Association is that physicians' services should be donated to Selective Service Examinations, the Board feels that physicians practicing radiology should do likewise; they waive not only their professional fees but also costs in excess of materials.

Some twenty States have adopted a schedule known as the Iowa Material Costs Schedule, which

is designed to cover the major portion of the costs of materials used and expended in diagnostic x-ray examinations. The Board believes that the precedent set by these states is sufficiently noteworthy that other states may now consider following it.

Should the volume of work be unduly burdensome on any one radiologist, he may and perhaps should request the Chief of his Medical Advisory Board to see that other radiologists are appointed from his area.

Mac F. Cahal
Executive Secretary

ANOMALIES OF THE COLON

To the Editor:

The recent paper by Dr. Albert Oppenheimer,* whose excellent contributions are well known to American readers, contains what I believe to be some surprising statements regarding colonic anomalies. I would like the privilege of presenting some objections to their acceptance.

Dr. Oppenheimer writes (p. 183): ". . . the position of the normal colon during life varies with two factors: (1) the shape of the abdominal cavity, which depends in turn on the condition of the abdominal muscles; (2) the physiologic phase of the activity of the colon during examination, e.g., at the time when the film is exposed." This statement contains two half-truths and one important omission. That the shape of the abdominal cavity depends on the condition of the abdominal muscles is not entirely true because it depends ever so much more on the stature or habitus of the individual. Similarly the physiologic phase of activity is of very minor importance in affecting the position of the colon since the basic intestinal pattern remains recognizable during every phase of activity (see Fig. 14). Actually the characteristic shape of the colon depends almost entirely on the presence or absence of congenital anomalies, a factor which the author does not even mention. This error of omission is serious because it disregards entirely the teachings of embryology and implies that such well-established concepts as variations in length, rotation, descent, and fixation are without influence on colonic size, shape, and position.

On page 184 one is led to believe that the colon simply "adapts itself to the space available within the abdominal walls," that "the colon appears to be short in the globe type, but dropped in the flat abdomen," and that "In reality there is not much difference in length between the two, if any." This conclusion is arrived at from the author's observations that lateral views in stocky persons show some forward and backward curves that escape detection in the posteroanterior projection. Though this may be technically correct, it is still of no practical importance because the more accurate the method used, the more conclusive is the proof that the length of the colon, instead of being constant, varies widely in different individuals. This can be demonstrated either by the technique of postmortem measurements as was employed by Bryant,[2] by the study of colonic length and pattern immediately after birth as was done by Larimore,[10] or by the estimation of the amount of enema fluid required to fill to the cecum in the living adult subject, as was used by myself.[9] Strangely enough, Dr. Oppenheimer apparently recreates the fundamental errors made by Treves[13] in 1885 who claimed that "differences in the length of the intestine depend upon physiological and not upon morphological data" and that "the length of the intestine and especially of the colon, is singularly constant"—errors that were handed down for decades as "anatomical properties" until exploded by the conscientious and meticulous studies of the late John Bryant of Boston. Bryant showed that there was a variation of 100 per cent in the length of the colon demonstrable not only at all periods during life but as early as the fifth month of intrauterine existence as well.

On page 185 in Oppenheimer's paper one reads: " . . . the recognition has gained ground that too much importance should

* The position of the colon. Am. J. Roentgenol. & Rad. Therapy, February, 1941, *45*, 177–186.

not be attributed to the various anomalies of the position of the colon, such as low cecum, the ptosed transverse colon, hypo- or hyperfixation, and hypo- or hyperrotation of certain loops. All these alleged anomalies are compatible with perfect colonic function. The observations above reported show that some of these variations are not only irrelevant, but even non-existent, being optical illusions." The selection of anomalies listed in the first sentence of the above quotation is not a happy one. Thus, the ptosed transverse colon is not considered seriously by modern writers. The redundant colon, on the other hand, is clinically very important and its omission is unfortunate. The reference to optical illusions is based on the fact that the author succeeded in showing that a low cecum, which appeared to lie in the pelvis in the posteroanterior view, was actually situated in front of the symphysis in the lateral view. This demonstration was made on a movable low cecum at six hours—a finding so near the border line that it might well be considered normal. Had the examination been made on a fixed low cecum at twenty-four or forty-eight or seventy-two hours, it would have been more convincing. The use of the expression "alleged anomalies" almost suggests bias on the part of the writer; but most revealing of all is the naive statement that "anomalies are compatible with perfect colonic function." It is of course the very pith and marrow of all anomalies that they are compatible with health for long periods of time. The dictum, "anomalies may cause symptoms in some of their bearers all the time, in all of their bearers some of the time, but are under no obligation to cause symptoms in all of their bearers all of the time," has often been employed by me to stress their peculiar nature and to emphasize their exsential difference from organic diseases.

As for the "degree of importance" that should be attributed to the various anomalies, would Dr. Oppenheimer content himself with the remark that a low cecum, a Meckel's diverticulum, a high cecum, and a redundant colon are "all compatible with normal function" when he knows that under certain circumstances these very anomalies may be responsible, respectively, for an erroneous diagnosis of appendicitis, a perforation with peritonitis, a subhepatic appendicitis mistaken for a cholecystitis, and an acute volvulus resulting from unwarranted purgation?

It is because anomalies exist as potential symptom-producers that their study is useful and the dissemination of correct ideas concerning them is so important. After all, the only practical question regarding an anomaly is: What is its clinical significance, and to what symptoms—be they negligible, mild, or catastrophic—does it predispose its bearer? There is, it seems to me, only one way to answer this question, and that is to assemble as large a series as possible of the various colonic anomalies, record the clinical symptoms in the same individuals and then correlate the two sets of findings. The results should then be checked against a similar set of correlations in a control series lacking these anomalies. The conclusions thus finally deduced stand ready to be confirmed or refuted by anyone who may take the trouble to repeat the same procedure. Almost twenty years have elapsed since, without any preconceived notions, I set myself the task of seeking an answer to the above question. It is a source of satisfaction to record that those who have taken similar pains have, in general, come to essentially similar conclusions (among others, White,[14] Gauss[8] and Feldman[6] in the United States; Flemming Möller[7] in Denmark; Bush[3] and Shanks[12] in England; Dagnino[5] and Bonorino Udaondo[1] in Argentina; Chiray, Lomon and Wahl[4] in France; and Piccinino[11] in Italy).

JOHN L. KANTOR

REFERENCES

1. BONORINO UDAONDO, C., MAISSA, P. A., and D'ALOTTO, V. Aspectos radiológicos y clínicos de algunas malformaciones del ceco-ascendente. *Prensa méd. argent.*, 1939, *26*, 2350–2357.
2. BRYANT, J. Observations upon the growth and length of the human intestine. *Am. J. M. Sc.*, 1924, *167*, 499–520.

3. Bush, G. B. Redundant colon. A group of cases exhibiting symptoms traceable to this condition. *Bristol Med.-Chir. J.*, 1928, *45*, 181–186.
4. Chiray, M., Lomon, A., and Wahl, R. Le dolichocolon. Masson et Cie, Paris, 1931.
5. Dagnino, A. Dolicocolias. *Semana méd.*, 1930, *2*, 1780–1815.
6. Feldman, M. Clinical Roentgenology of the Digestive Tract. William Wood & Co., Baltimore, 1938.
7. Flemming Möller, P. The redundant colon. *Acta radiol.*, 1926, *6*, 432–457.
8. Gauss, H. Redundant colon. *Arch. Surg.*, 1927, *15*, 560–579.
9. Kantor, J. L. Colon studies. IV. The roentgen diagnosis of colitis. Am. J. Roentgenol. & Rad. Therapy, 1927, *17*, 405–416.
10. Larimore, J. W. The human large intestine in the new-born and in the adult. *Ann. Clin. Med.*, 1926, *5*, 439–463.
11. Piccinino, G. L'indagine radiologica nelle malattie del grosso intestino. *Atti d. X Cong. ital. di radiol. med., Parma*, 1932.
12. Shanks, S. C. Congenital abnormalities of the colon. *Brit. J. Radiol.*, 1937, *10*, 261–281.
13. Treves, F. Anatomy of the intestinal canal and peritoneum in man. *Brit. M. J.*, 1885, *1*, 415.
14. White, F. W. Studies of the redundant colon. *Tr. Am. Gastro-Enterol. Ass.*, 1927, *29*, 132–146.

RADIOLOGICAL CONFERENCE

The Seventh Annual Midsummer Radiological Conference in the Rocky Mountains will be held at the Shirley-Savoy Hotel in Denver, Colorado, July 31, August 1 and 2, 1941. The guest speakers will be Dr. Ross Golden, New York City; Dr. D. S. Beilin, Chicago; Dr. John D. Camp, Rochester, Minn.; Dr. Leon J. Menville, New Orleans; Dr. John T. Murphy, Toledo; Dr. U. V. Portmann, Cleveland; Dr. Wendell G. Scott, St. Louis.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 105 Rutledge Ave. Charleston, S. C.

A CONTRIBUTION TO THE LOCALIZATION OF FOREIGN BODIES

A COMBINED ROENTGENOSCOPIC METHOD FOR QUICK AND ACCURATE LOCALIZATION*

By RENÉ J. GILBERT, M.D., *and* HENRI U. HERTENSTEIN, Ph.D.
GENEVA, SWITZERLAND

THE method we are going to describe has no claim to originality—we agree in this respect with Didiée[1]—it is a roentgenoscopic method which combines the use of the well known device of Strohl[2] with the measurement of the ensuing tube shift.

In view of the existing methods it may seem idle to try to find new ones. The reason is—we have been engaged on this problem since September, 1939—that the extremely heterogeneous roentgenologic apparatus and tables available in our country do not allow a straight-forward adoption of any of the recognized rapid methods.

The difficulties we are facing here are, to a great extent, due to the fact that most of our modern roentgen-ray tables are fitted out with a screenholder coupled in a non-detachable manner with the tube or tube head. Tube and screen are thus bound to move together and any localization method requiring a tube moving independently of the screen (Strohl, Patte and others) is unworkable. Therefore we had to discard the methods of Strohl and others recommended for the purpose.

In those equipments where independence of screen and tube movement had been provided for, other difficulties arose which hampered considerably the speedy and accurate working of those methods. We mention here only a few of these: the too heavy construction of the screen frame involving a bending of the arm and consequently an inclined position of the screen, cassette enclosures beneath the screen preventing a direct measurement of the screen—skin distance, difficulties in locking the screen arm against involuntary horizontal movements. All these deficiencies necessitate an undue amount of correction and should therefore be avoided.

Starting with the study of the Strohl method and the possibilities of some modified forms, we finally found out that the use of the Strohl localizing cone or a simple cross wire holder combined with the measurement of the ensuing tube shift adds considerable advantages as will be seen by the following comparison† (Fig. 1).

If we shift the focal spot F from the first (skin marking) position parallel to the table and to the left, both M_1 and M_2 being fixed to the tube or tube head (M_1 and M_2 are equidistant from C and F) must move with it and at a certain point F', M_2' and P will fall on the same line, the shadow of M_2 in the position M_2' will coincide with that of P at P_2. Shifting the focal spot to the right will bring F'', M_1'' and P into the same straight line $F''M_1''P_1$.

Since FM_2 is parallel to $F'P_2$,
FM_1 is parallel to $F''P_1$,
and $F'F''$ is parallel to M_1M_2,

† We follow here closely the description given in the United States Army X-ray Manual, 1925, pp. 219–224, Method A.

* Institut universitaire de Radiologie médicale, Genève. Director, Professeur René J. Gilbert.

the triangles FM_1M_2 and $PF'F''$ are similar, consequently the following equation is valid: $X/D=h/d$, hence $X=D\ h/d$, the latter ratio h/d being constant and fixed once for all for a particular set.

The same operation has to be repeated for the skin mark S; the tube shift D' required to establish the coincidence between the shadows of the skin mark and the wires is naturally greater than D. For the sake of a clear design we have not marked this position in the diagram of Figure 1.

We have therefore for the skin mark:

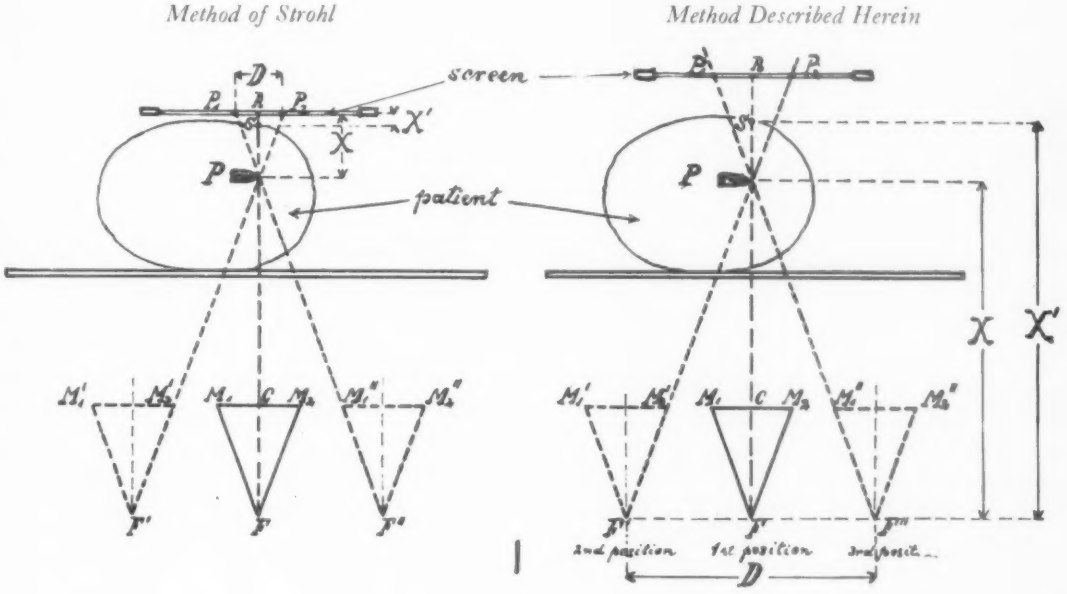
$$X'=D'\ h/d,$$

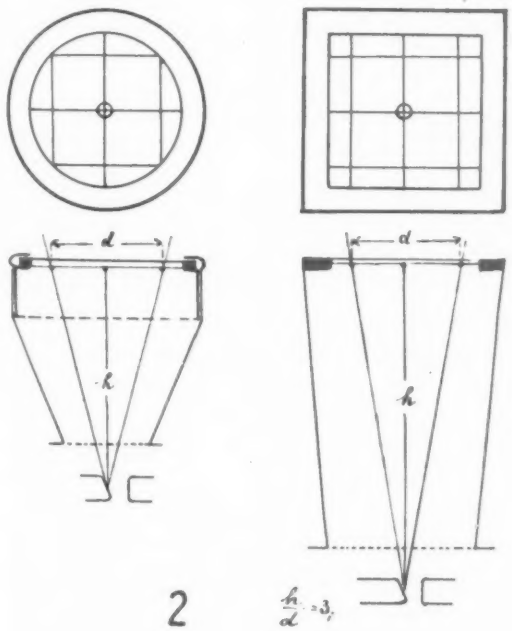
and as shown by the foregoing lines

$$X=D\ h/d,$$

the following equation is valid:

$$X-X'=D\ h/d-D'\ h/d=h/d(D-D').$$





FIGS. 1 and 2. Diagrams explaining localization method. F, focal spot of the tube, 1st position, for marking the skin; F', focal spot of the tube, 2nd position, after shifting to the left; F'', focal spot of the tube, 3rd position, after shifting to the right; M_1 and M_2, metal wires (attached to the localizer cone or frame); M_1' and M_2', metal wires, 2nd position, after shifting to the left; M_1'' and M_2'', metal wires, 3rd position, after shifting to the right; P_0, shadow of projectile by the vertical ray; P_1, shadow of projectile by the ray through M_1''; P_2, shadow of projectile by the ray through M_2'; P, projectile; C, center of cross wires (attached to the localization cone or frame); S, skin mark; d ($=M_1M_2$), distance between the metal wires M_1 and M_2; h ($=FC$), distance between focal spot and plane of the metal wires; D, distance between position F' and F'' of the focal spot (or between the shadows P_1 and P_2 in the left hand figure of the Strohl method); X, distance between focal spot F and projectile P (or between screen and projectile in the left hand figure for the Strohl method); X', distance between focal spot F and skin mark S (or between screen and skin mark in the left hand figure for the Strohl method); $X-X'$, distance between skinmark and projectile measured on the vertical ray.

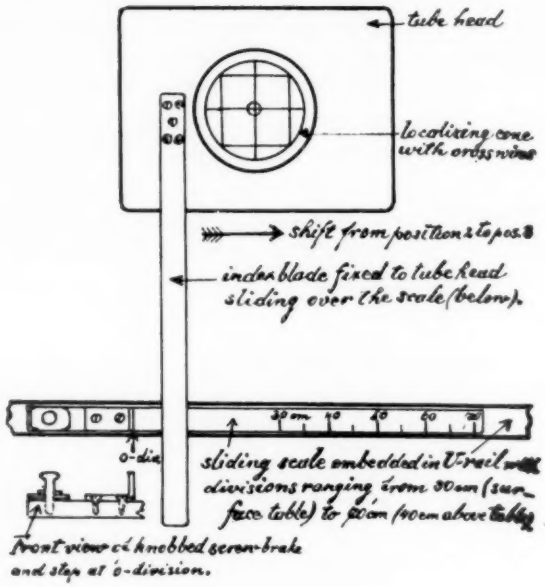

tube head
localizing cone with crosswires
shift from position 2 to pos. 3
index blade fixed to tube head sliding over the scale (below).
0-dia
sliding scale embedded in V-rail with divisions ranging from 30 cm (surface table) to 70 cm (40 cm above table)
Front view of knobbed screw-brake and stop at 0-division.

FIG. 3.

That is to say: The *distance* between *skin mark* and *projectile* = the *difference* between the *tube shifts* multiplied by the constant h/d.

The advantages derived from the direct measurement of the focal spot shift are obviously the following:

(a) The measurement is done on a scale properly devised for the purpose (description given below) and conveniently placed —within easy reach of the operator— on one side somewhat below the table.

The readings of the scale—one for each shift—need no corrections whatever, they can be quickly repeated, the only manipulations required being those of shifting the tube and the scale (see description below). There is no measuring device above the table, the table can therefore be quickly cleared and made ready for other patients.

(b) The fluoroscopic screen may be used freely in any reasonable position and distance, since it serves the only purpose of observing the coincidence of the shadows of the projectile, skin mark and metal wires of the localizer cone or frame. It may even be replaced by a hand roentgenoscope or a "bonnette" attached to the head.

The method may therefore be applied to localizations: (1) on tables with screens coupled with the tube (these types of tables are common in our country); (2) on tables with screens moving independently; (3) on fracture roentgen tables, the surgeon working in the bright light of the operating room, the roentgenologist with fluoroscope ("bonnette") attached to his head ready to guide him through intermittent controls during the extraction (method of Ombrédanne and Ledoux-Lebard[4]); (4) on stretchers placed on the roentgen table.

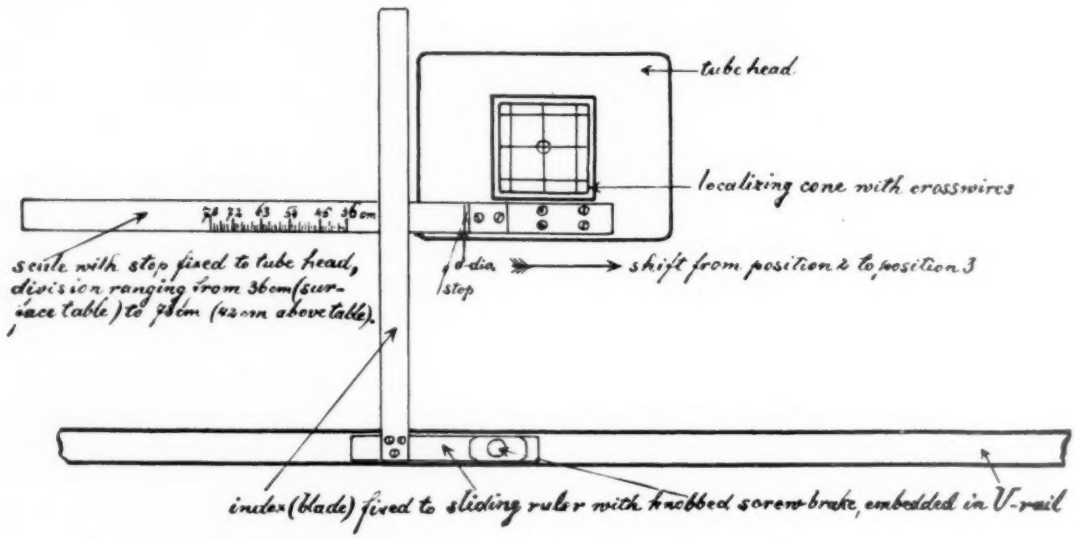

tube head
localizing cone with crosswires
78 72 63 54 45 36 cm
scale with stop fixed to tube head, division ranging from 36 cm (surface table) to 78 cm (42 cm above table).
0-dia
stop
shift from position 2 to position 3
index (blade) fixed to sliding ruler with knobbed screw-brake embedded in V-rail

FIG. 4.

As stated in the beginning of this paper, the problem before us was to find a method and apparatus adaptable to the prevailing types of roentgenologic equipment in our country. Most of these types were not appropriate at all for field work (a standard outfit for field work does not for the time being exist), so that we cannot show in the following pages a standard outfit of the localizing apparatus. What we are going to describe are the essential elements of such an outfit as we have tried out and found to give satisfactory results. The manufacturers of roentgen-ray equipment will probably find it easy to choose the elements most suitable for their units.

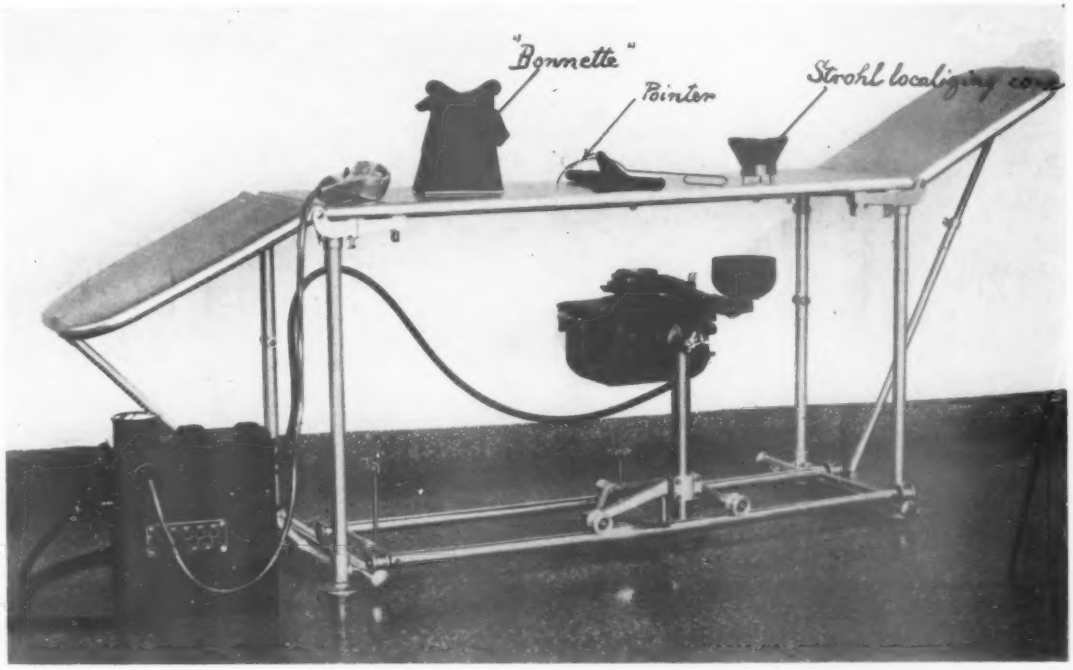


FIG. 5. General view of a field unit (French Army model) with its normal equipment for localization. Screen and screenholder are removed and not shown in this illustration. The table is ready for the surgeon's work—localizing cone and screen with screenholder being removed for this purpose.

The elements we have provided for our localizing outfit consist essentially of the following:

(a) A "Strohl localizing cone" or simply a frame carrying a cross wire (ring marked) and a couple of parallel equidistant wires (see Fig. 2). The distance between the parallel wires is set according to the chosen ratio h/d; wherever conditions permit (in all the cases where the screen is moving independently from the tube) h/d should equal 2, in other cases (on tables with screens coupled with the tube) $h/d=3$ is probably the suitable ratio. (On tables with screens of exceptionally small size coupled with the tube, a ratio of $h/d=4$ may be admitted, the exactness of measurement resulting from such a ratio is naturally smaller than for the ratios 3 or 2.)*

(b) A device for measuring the tube shift. This device consists of an index (steel or bronze blade) and a scale which for the sake of a simplified and quick reading is made sliding (see Fig. 3). In most of the cases we had to deal with we were able to fix the index to a suitable portion or projection of the tube head or tube carriage, the sliding rule being embedded in a U-shaped

* The cross wires should be brought as near as possible to the table; in other words, h should be made as great as possible; the tube should be set at a right angle to the table and the thickness of the spotting wires should be in proportion to the diameter of the focal spot.

rail attached to the feet of the table at a convenient height.

The sliding rule is provided with a scale giving the distances X and X' in centimeters and fractions thereof for the given ratio h/d. The scale is, as stated above, not a centimeter scale, but the readings give the focal spot-projectile distance $D\ h/d$, or focal spot-skin mark distance $D'\ h/d$, in centimeters and fractions thereof. Apart from the scale, in order to keep it fixed during the movement of the tube, the rule is fitted out with a kind of brake working through a knobbed screw (see Fig. 3), and in order to set the O-division quickly in its position once the second position of the tube has been established, a stop at this O-division is fixed which allows the scale to be brought quickly into contact with the blade of the index. The shifting of the tube into the third position moves the blade over the scale up to the division corresponding to the shift. We have thus only *one* reading for *one* shift.*

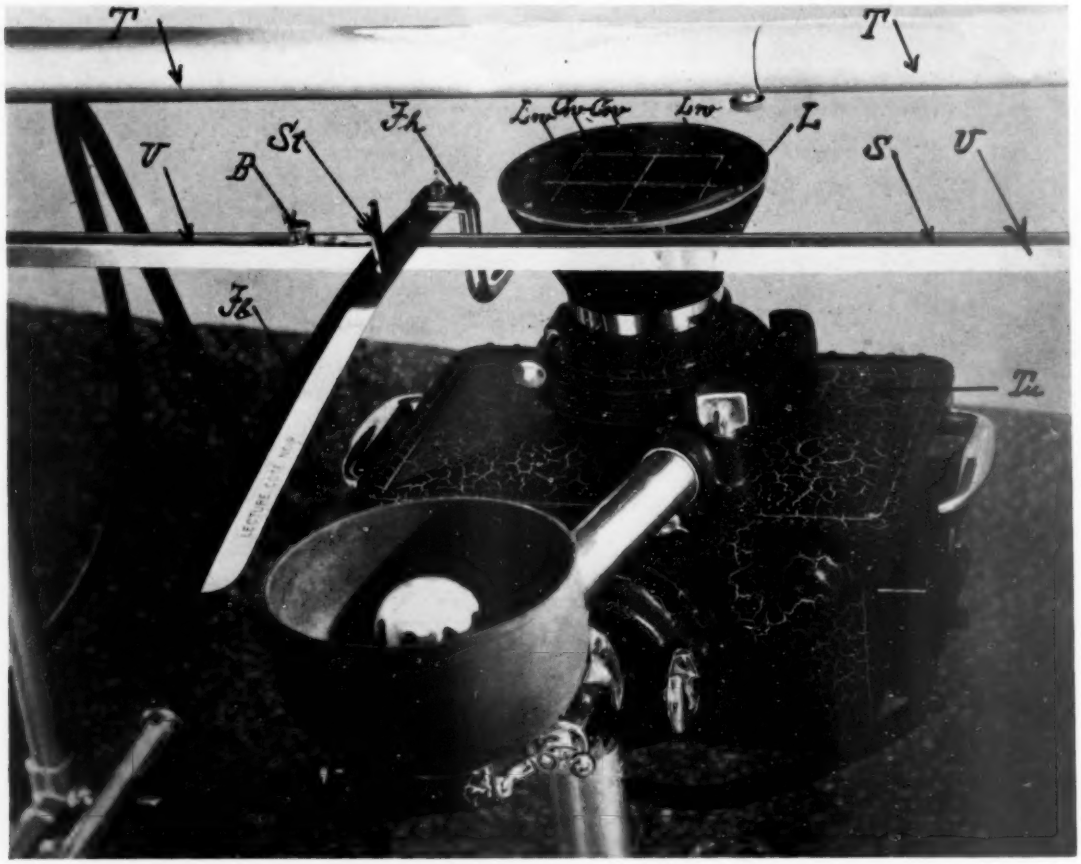


FIG. 6. Details of the measuring device we have adapted to the table shown in Figure 5. The illustration shows the stop (*St*) of the scale just touching the index blade, a position corresponding to the "2nd position" in the diagram of Figure 1. *T*, table; *U*, U-shaped rail; *L*, localization cone (Strohl); *Lw*, localizing wires (parallel and equidistant); *Cw*, cross wires; *St*, stop (fixed to the scale) set at the *O*-division of the scale; *B*, knobbed screw brake (fixed to the scale); *Ib*, index blade; *Ih*, index holder; *S*, scale; *Tu*, tubehead.

It may be worth while to mention a case where we had to invert the positions of the index and the scale, that is to say we had to fix the scale to the tube head and embed

* The index blade as well as the rail have to be made long enough to allow for the travelling of the tube in both directions. In order to give a true record of the tube shift the choice of the portion or projection where the index is going to be fixed on has to be made very carefully.

the ruler carrying the blade (ruler and blade set at a right angle) in a U-shaped rail at the side of the table, this rail being independent from the table (Fig. 4). The table could be easily removed and replaced by another table or stretcher. This case refers to an equipment which had been selected for field work (it was not a properly designed field unit) and had to be provided with a localizing device.

Figure 5 gives a general view of a field unit which we had to provide with a localizing outfit of our design. The field unit (built by the Compagnie Générale de Radiologie, Paris), is normally equipped with a "Strohl localizing cone."

Figure 6 shows the details of the measuring device (index-blade and scale) we had adapted in addition to the "Strohl localizing cone."

SUMMARY

The method described above has a wider field of application than the method of Strohl.

Its principal characteristics are the absence of measuring devices above the table, the use of any kind of screen at any reasonable position and distance and the absence of any additional measurements and corrections.

The desirable features of a localizing apparatus as set forth in the United States X-Ray Manual seem to us satisfactorily met with.

REFERENCES

1. DIDIÉE, J. Le repérage des projectiles par les rayons X: principes fondamentaux. *Monde méd.*, 1940, *50*, 82–88.
2. STROHL. Procédé simple pour localiser rapidement des projectiles par la radioscopie. *J. de radiol. et d'électrol.*, 1916–1917, *2*, 172–173.
3. United States Army X-Ray Manual, 1925.
4. OMBRÉDANNE, L., and LEDOUX-LEBARD, R. L'extraction des projectiles à l'aide du controle intermittent de l'écran. *J. de radiol. et d'électrol.*, 1916–1917, *2*, 65–78.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD AND NECK

Dearing, W. Palmer. Tuberculin and x-ray survey. *Am. Rev. Tuberc.*, Dec., 1939, *40*, 640–653.

A previous publication by the author and associates indicated a lack of uniformity and lack of correlation between tuberculin findings and morbidity and mortality rates. Both the stock and the dosage are varied by different observers so that it is important for each one to describe exactly his procedure. This paper concerns tuberculin testings of 4,500 white residents of Giles County, Tenn., accomplished by the U. S. Public Health Service in 1936. The Mantoux method single dose of 0.000, 5 mg. PPD was used. Eighty-seven per cent of the tuberculin reactions were read in forty-eight hours and the remainder at seventy-two (no significant difference in incidence of reactions between the two groups). Posteroanterior roentgenograms (using 15 ma.) were used to independently check the results.

The tuberculin reactions varied from less than 20 per cent in children (of high school age) to 70 per cent or more in the older age brackets. Old tuberculin testings showed higher rates for the younger groups, though no significant difference for the older groups. Among the five to nine year age group, 27 per cent of the boys and 31 per cent of the girls showed calcifications (youngest child showing calcifications was only two years of age). There was no evidence of increase in the size of these lesions with older years; instead the incidence was slightly less among the older groups, indicating that calcifications are not progressive but instead that there is a tendency toward absorptions. Of tuberculin positive cases, 35.4 per cent showed calcifications while 34.2 per cent of the tuberculin negatives did likewise; 22.7 per cent of these showed multiple lesions (in the peripheral lung fields); 51.9 per cent were right sided while 34.9 per cent were located in the left side. Single lesions were usually located in the lower lung fields. There was no significant difference in the incidence of positive tuberculin reactions whether these lesions were multiple or single or whether the lesions were located in the upper or the lower lung fields, rather suggesting that etiological factors others than tuberculosis were probably not responsible. One and three-tenths per cent of the group showed reinfection lesions. Of these, 10 were non-reactors (0.3 per cent of 3,270) whereas 47 were positive reactors (4.2 per cent of 1,107). Two of the 10 were later reclassified, one as fungus, the other as epituberculosis.

The author concludes that single-dose Mantoux testing is a reasonably efficient screen for case-finding where the cost limits the number of roentgen examinations, but the roentgen ray is still the basic tool in case-finding.—*A. A. de Lorimier.*

Ianne, Charles L. Mass tuberculin testing and x-raying. *Am. Rev. Tuberc.*, Dec., 1939, *40*, 654–656.

"Prevention of tuberculosis should begin before birth." The author emphasizes the importance of routine tuberculin testings of expectant mothers and photoroentgenography of the positive reactors. Of 691 tests conducted between June 1, 1936, and June 1, 1938, 284 (41 per cent) reacted positively to 1:1,000 old tuberculin. Of these reactors, 32 failed to return for roentgen studies but there were found: 10 cases of minimal tuberculosis; 1 moderately advanced and 1 far advanced—an incidence of

1.7 per cent. Proper care was instituted and as a result, none have shown extension or clinical manifestations of disease. Only one child became infected.—*A. A. de Lorimier.*

DOUGLAS, BRUCE H. X-ray findings in tuberculin reactors and nonreactors. *Am. Rev. Tuberc.*, Dec., 1939, *40*, 621–633.

Various methods of providing mass examinations of the chest are discussed. Chadwick is quoted in emphasizing the inadequacy of physical examinations of the usual type; the expense of ordinary roentgen film studies; limitations in their interpretation when the examination is limited to the roentgen studies and the practicalities of "screening" by means of skin testings (with roentgen studies of the positive reactors).

Tuberculin reactions may be negative in cases having densely calcified lesions or even with lesions of lesser degrees of scarring. Still, "there is little evidence to indicate that persons with really active tuberculous lesions of either primary or reinfection type fail to react to tuberculin, except in well known circumstances, such as during certain acute communicable diseases, terminal states of or very acute forms of tuberculosis itself, the later weeks of pregnancy and following certain severe surgical operations."

Lawrason Brown and his associates have listed the following criteria for the diagnosis of pulmonary tuberculosis: (1) history of pleurisy; (2) history of hemoptysis; (3) the finding of râles in the upper third of the lung or lungs; (4) the roentgen evidence of a typical lesion, and (5) the finding of tubercle bacilli in the sputum. These criteria were suggested for individuals presenting diagnostic problems; they were not intended for survey work. Roentgen findings were definite in 96 per cent of the cases.

For surveys, the following procedures might be followed: (1) fluoroscopy—with it, no permanent graphic record is provided and the diagnostic accuracy is limited; (2) sensitized paper—though considerable improvement in the emulsion has been accomplished in recent years, nevertheless it is still important that it be protected by cold storage; moreover, the cost of it is still too expensive for large scale work; (3) 14×14 inch transparent films might be used to effect a 20 per cent saving; (4) miniature films—4×5 inch or even 35 mm. dimensions might be used—these provide for material savings. Nevertheless, the author emphasizes the risk of trusting individual interpretations. He emphasizes the value of tuberculin skin testings to provide for "screening." It is especially valuable in the study of infants. Of course this combination study requires two visits by the individual and the problems concerned with getting the subject back. It is much easier to persuade people to have roentgenograms made than to have a scratch, a needle prick or even a patch on the arm. Tuberculin tests might be obtained following positive roentgen findings. Quoting from the case finding study which was conducted in Detroit it was found that 0.58 per cent of all had clinical tuberculosis whereas the positive group represented 2.02 per cent of the positive tuberculin reactors. Only 29.1 per cent of the total group showed positive skin reactions—though, as Long has shown, some of these might have had primary infections and subsequently have become tuberculin negative.—*A. A. de Lorimier.*

RILANCE, A. B., and HOWLETT, KIRBY A., JR. Nontuberculous upper lobe bronchiectasis. *Am. Rev. Tuberc.*, August, 1939, *40*, 204–214.

Roentgenological evidence of a parenchymal lesion in the upper third of a lung, particularly if accompanied by hemoptysis, should serve as presumptive evidence of pulmonary tuberculosis. This is particularly true for cases where the general health is impaired and where a chronic cough and expectoration are conspicuous symptoms. Nevertheless, not a few patients have spent prolonged periods of treatment in tuberculosis sanatoria because of errors in diagnosis. The authors present abstracts of 3 cases of this sort; cases wherein the presumptive diagnosis of pulmonary tuberculosis had been made though other etiology was recognized later.

The first case was a white female, aged forty, who had suffered from episodes of cough and expectoration since the age of fifteen. Eight years previously, she had had a pneumonia and from the following year her general health had been impaired with loss of weight, loss of appetite and copious sputum. Roentgenological studies revealed a definite infiltration in the right upper lobe. The tubercle bacillus could never be isolated from her sputum. Later film studies revealed a reticulated, honeycombed fibrosis, very suggestive of bronchiectasis. No change could be noted by way of serial studies made over the following four years. An actual cavity formation was revealed at one time and puddling of lipiodol was demonstrated. In all,

studies were conducted over a period of fourteen years during which time there was no significant change in her general condition.

The second case was a white male, aged twenty, who had had episodes of hemoptysis since the age of eleven. A single positive sputum was reported though 26 studies were negative. His general condition was excellent, weight being 195 pounds. Roentgenographic studies revealed infiltration to the third rib on the right, consisting of fine linear strands of fibrosis with a suggestive reticular appearance. A bronchogram revealed gross bronchial dilatation in the right upper lobe with puddling particularly in the first anterior interspace. Subsequent studies revealed increased haziness in this region though even later studies showed clearings. His general health continued excellent.

The third case was of a male, aged twenty-nine, who for almost a year had complained of malaise, anorexia, increased dyspnea, cough and expectoration. He had lost 6 pounds in weight and on one occasion had spit up considerable blood. Roentgenographic studies revealed a sharply demarcated dense shadow running from the right hilum to the extreme apex with peculiar thin walled annular shadows bordering it. The evidence suggested cystic bronchial dilatations with areas of atelectasis. This consideration was substantiated by lipiodol studies.

In summary, the author emphasizes the following: (1) in the presence of abundant expectoration of mucopurulent sputum, inability to find the tubercle bacillus over a long period of time should prompt the search for other causes. (2) if cavitation is due to tuberculosis, the tubercle bacillus should certainly be obtainable in the sputum; the absence of it should prompt study for another pathological explanation; (3) hemoptysis without general impairment of health is not characteristic of tuberculosis; (4) an active tuberculous lesion does not usually remain stationary, and (5) lipiodol should be used in doubtful cases to distinguish true bronchiectatic cavitations. Of course, tuberculosis may be responsible for the development of the bronchiectasis.—*A. A. de Lorimier.*

Hamman, Louis. Chronic nontuberculous basal infections of the lungs. *Am. Rev. Tuberc.*, Oct., 1939, *40*, 363–377.

This discussion has been prompted because of the author having segregated a group of cases which when first studied were thought to be pulmonary tuberculosis but in whom the organisms could not be obtained. Observations concern a ten year period (1905–1915) dealing with a group of the Phipps Tuberculosis Dispensary of the Johns Hopkins Hospital.

The following features were characteristic of the group: (1) cough and expectoration (not infrequently, hemoptysis); (2) chronicity; (3) irregular fevers; (4) localized moist râles in one or both lower lobes (probably more frequently on the left side), and (5) absence of general toxicity (as typical of tuberculous patients), lack of weakness, exhaustion or loss of weight.

The author and others have reported on this condition speaking of it as "chronic nontuberculous pulmonary infection." It is especially important among children and during early adult life (mostly between twenty and forty). The symptoms may develop insidiously or they might be precipitated by an ordinary "cold," "grippe," etc. Roentgenographically, little may be visualized other than prominent pulmonary markings and possibly pleural clouding. In some series, about 80 per cent have been found to harbor sinus infections. Even though the sinus involvement be cleared, there does not appear to be a clearing of the pulmonary changes (cases have been followed for more than ten years) and some develop an actual bronchiectasis. Direct and circumstantial evidence seems to indicate that these infections continue chronically because of changes in the walls of the smaller bronchi and in their lumina. Lipidol injections may not at first indicate a true bronchiectasis as most of us are inclined to recognize it but the relationship to it is evidenced by the finding of so many cases which progress to that definite degree.

When chronic infections have persisted for some years, there is no treatment that will cure them. Since life is not seriously jeopardized, the thing to do is to alleviate symptoms. This can be accomplished by reducing upper respiratory infections. The injection of lipiodol may be of value. Vaccines appear to be useless. Postural drainage, if systematically and faithfully carried out, is often beneficial. The value of roentgen therapy is quoted but the author is not familiar with it. The value of climate cannot be disputed. In the case of children it might be prudent to remove tonsils and adenoids.

Considerable discussion is presented as to the manner in which bronchiectasis develops; the considerations of the direct effects of re-

peated infections; the changes incident to bronchial stenosis, etc.—*A. A. de Lorimier.*

COHEN, SAMUEL. The evolution of haematogenous pulmonary tuberculosis into bronchogenic tuberculosis. *Am. Rev. Tuberc.*, August, 1939, *40*, 188–203.

It is generally recognized that tuberculous involvements of bones, joints, kidneys, brain, etc., develop by hematogenous disseminations. Regardless of the large vascular filter beds in the lungs, hemic implants of the tubercle bacillus there are rarely considered. Still it is reasonable to believe that this type of extension might occur either by way of lymphatic or vascular channels because of breakdown of caseous lymph nodes in the case of a primary lesion or from unstable reinfection lesions. Colored people in particular are known to have relatively poor tissue resistance and therefore to be subject to this type of spread.

Roentgenologically, hematogenous pulmonary lesions may present criteria such as the following: (1) More or less discrete bilateral miliary foci, frequently symmetrically arranged and usually in the upper parts of the lungs: (2) larger nodules of different sizes or softer patches in a less regular distribution; (3) fine, recticular, strand-like infiltration, possibly widening of the hilar zones due to enlarged lymph nodes, possibly thickened pleurae; possibly findings of calcified mesenteric nodes, and (4) visualization of calcification within the spleen.

With healing, these lesions may become strands, nodules of fibrosis or calcifications. Retrogression may lead to confluence of foci, cavity formations (usually shallow and thin-walled) whereby a primary lesion may simulate a progressive exogenous reinfection. Roentgenologically, these cases may simulate silicosis, cardiac decompensation, pulmonary fibrosis or miliary carcinomatosis. They are distinguishable with difficulty from the group where extension of the infection is due to bronchogenic spread though serial roentgenography should be an aid in this regard. Bronchogenic extensions are most likely when there is the history of hemoptysis or the findings of the organism in the sputum. Four case examples are presented. —*A. A. de Lorimier.*

RUBIN, ELI H. Haematogenous tuberculosis in the adult. II. Haematogenous pulmonary tuberculosis. *Am. Rev. Tuberc.*, Dec., 1939, *40*, 667–691.

Hematogenous infections of tuberculosis may be widespread or limited to the lungs. This paper is presented with the aspect of two questions: (1) Under what conditions does hematogenous tuberculosis affect mainly the lungs? (2) Are there any means of differentiating hematogenous pulmonary tuberculosis with the lungs the dominant seat of localization, from that in which the lungs are involved as part of a systemic tuberculosis? In discussing the general physiological principles, abstracts of 10 cases are presented.

Dissemination by way of the bronchial arteries appears to favor the formation of small, evenly dispersed tubercles, while dissemination by way of the pulmonary arteries favors the formation of tubercles of larger size in acinous groupings. Otherwise there appear to be no distinguishing characteristics which might serve to typify "lesser circle" (bronchial arterial) versus "greater circle" (pulmonary arterial) tuberculosis nor to indicate widespread versus localized disseminations. Once the organisms have invaded the bronchial tree, the entire picture changes. The acuteness or chronicity of symptoms and the outcome in the individual instance depend on humoral factors which cannot be correlated with the manner of development of the disease.—*A. A. de Lormier.*

OATWAY, WILLIAM H., JR, Laryngeal changes in acute haematogenous tuberculosis. *Am. Rev. Tuberc.*, Oct., 1939, *40*, 378–388.

Various types of tuberculous involvement might progress to advanced stages without recognition. The tubercle bacillus might involve the larynx, the epiglottis, the pharynx and the palatine arch with resultant edema of those tissues. Actual injection of the tissues is rare. Not infrequently, necrosis and ulcerations may develop. Hoarseness, aphonia, pain and dysphagia are characteristic.

Of 39,752 cases admitted to the Wisconsin General Hospital, there were 720 cases (1.8 per cent) with pulmonary tuberculosis; 25 with miliary; 101 with laryngeal tuberculosis. Analyses indicated a close parallel between cases of miliary and cases of laryngeal involvements. Sixteen of the 19 laryngeal cases were males. The average age was 45.5 years. In most cases the associated pulmonary involvement was chronic (the sputum was positive in all but one case; 16 of 18 cases showed cavities). Most of the acute laryngeal cases had a background of

chronic symptomatology and the acute phases were usually ushered in by a sudden change in the general health of the individual. All except one of the 19 acute laryngeal cases were rapidly fatal.

The author emphasizes that both the chronic and the acute forms of laryngeal tuberculosis are too seldom considered. They serve as a very considerable menace because of this fact since they may be placed on any ward or service and thereby distribute the organisms to other patients.—*A. A. de Lorimier.*

Floyd, Cleaveland, and Hepburn, Robert H. Calcification of the pleura. *Am. Rev. Tuberc.*, August, 1939, *40*, 215–223.

Various statistical studies have indicated that pleural calcifications are preceded by pleural effusions or empyema. Yet the incidence of these calcifications is low: Ulrich, reporting on 1,845 cases, cited an incidence of 0.87 per cent; the authors found the condition in only 28 cases of more than 15,000 reontgenological chest examinations. Not more than one-fourth of these showed evidence of previous pulmonary lesions. Most of them were of middle or later life. The predisposing causes included actinomycosis, empyema, pleurisy with effusion, tuberculosis and trauma.

Aschoff described autolysis of blood albumin, acting to seize lime from the blood. Pritchard considered several steps: (1) lowered tissue vitality following injury or infection, (2) impaired circulation of the part and (3) hyaline degeneration—into which calcium salts are deposited. Wells likewise emphasized the relationship of calcification to degeneration or decay of tissue. The authors believe it to signify there has been extensive tissue damage. Clinical symptoms are to be expected when the vital capacity of the lungs has been reduced.—*A. A. de Lorimier.*

Geary, Paul. Extrapleural pneumothorax. *Am. Rev. Tuberc.*, July, 1939, *40*, 9–25.

Extrapleural pneumothorax is not enthusiastically advocated but certain favorable features as well as limitations of it are cited. Though seldom considered, it was performed as long ago as 1910. It might be used for certain cases rather than extrapleural thoracoplasty. Both paraffin and air have been used for compression.

The author cites the following indications: (1) bilateral disease where intrapleural pneumothorax is impossible or unsatisfactory and thoracoplasty contraindicated; (2) contralateral thoracoplasty; (3) asthma or any condition where there is a low vital capacity; (4) childhood and early adolescence; (5) acute progressive activity where intrapleural pneumothorax is impossible because of the danger of aggravation of toxicity, and (6) hemorrhage and basilar cavitation.

Fifty-five of these operations were performed by the author among 53 patients. Under combined general and local anesthesia (cyclopropane and novocaine) a liberal surgical approach is made to the region of the lesion. A portion of one or at the most two ribs is removed and with blunt digital dissection, the parietal pleura is detached from its overlying tissues. The wound is closed and the air is injected into the extrapleural space twenty-four hours later. In some instances the injection was made earlier (particularly to control bleeding). Subsequent injections were made under fluoroscopic control in order to accomplish the desired compression. Smaller refills were given from time to time.

The complications are concerned with the leaving of the "dead space." Of the 55 operations, in 5 infections did occur—3, tuberculous and 2, pyogenic. There were 4 deaths. These occurred within ten days of the time of the operation and in most instances could be attributed to aggravation of the lesion incident to the surgery and inability to adequately collapse or to too sudden collapse of the involved portion of the lung. One death was due to a *Streptococcus viridans* infection.

In general, this type of surgery might be considered instead of thoracoplasty to collapse a small area of diseased pulmonary tissue, with the idea of allowing re-expansion of the extrapleural pneumothorax after it is estimated that healing has occurred.—*A. A. de Lorimier.*

Finkelstein, Max. Transmediastinal hernia; mediastinal movements during respiration in bilateral pneumothorax. *Am. Rev. Tuberc.*, Sept., 1939, *40*, 281–291.

Transmediastinal herniations are not infrequently seen after unilateral pneumothorax. They are usually located either in the anterior aspect of the superior mediastinum (just behind the manubrium) or in the inferior aspect of the posterior mediastinum (between the aorta and the esophagus). Fluoroscopically, side-to-side

movements of the mediastinum are seen during respiration—the hernia being the largest at the end of expiration and least conspicuous at the end of inspiration. The author has been able to find reports of only 6 such cases as complications to bilateral artificial pneumothorax. Three additional cases are reported. All the cases were young women in whom the actual disease began during adolescence. In every instance the hernia extended from the right side and was situated in the anterior mediastinum. The hernia and the heart and mediastinum moved away from the side of origin during inspiration and toward that side during expiration. The author concludes that the shift during respiration is due to unequal inflation and deflation of the two lungs. Contributing factors probably include: (*a*) presence of the usual "weak spot," (*b*) lack of fibrosis in the pleura and mediastinum, and (*c*) differences between the right and left intrapleural pressures. The condition may be duplicated by rubber ball experiments which are described.—*A. A. de Lorimier.*

IRONS, ERNEST E., and APFELBACH, CARL W. Aspiration bronchopneumonia, with special reference to aspiration of stomach content. *J. Am. M. Ass.*, Aug. 24, 1940, *115*, 584–587.

A frequent pulmonary disease, aspiration bronchopneumonia, the pathogenesis of which seems not to be generally recognized, is related to the aspiration of material from the alimentary tract, usually material from a dilated stomach. This form of aspiration bronchopneumonia is characterized by hemorrhage, hypermia, edema and advanced postmortem and retrogressive changes in the lungs. The pulmonary complications to be discussed concern acute hyperemia, hemorrhagic and edematous alteration in lung tissue and acute tracheobronchitis. Anatomically these have been variously called "hyperemia and edema of the lungs," "hypostatic bronchopneumonia," "pneumonitis" and "postoperative bronchopneumonia."

For the recognition of bronchopneumonia caused by the aspiration of material from the gastrointestinal tract, it is important that necropsy be done within an hour or two after death. The lungs are overdistended with air and do not collapse when the sternum is removed, owing to the presence of aspirated material and exudate in the bronchial tree and to the presence of hemorrhage and edema of much of the lung tissue. The lungs are increased in weight due chiefly to hemorrhage and edema of the alveolar spaces. In cases in which there are no pulmonary complications, the lungs undergo postmortem change slowly. Hence, advanced changes in the lungs indicate that material has been introduced into them that can accelerate postmortem alterations. When the bronchial tree is examined a prominent characteristic is intense hyperemia, usually of a much greater degree than that observed in pneumonia caused by the pneumococcus. In acute aspiration bronchopneumonia, the bacterial flora of the lung, bronchial tree and stomach are almost identical, multiplicity of kinds of organisms is the rule, and the organisms are of the type commonly found in the gastrointestinal tract in the absence of free hydrochloric acid in the lumen of the stomach.

The characteristic microscopic changes are intense engorgement of the alveolar capillaries with erythrocytes, edema and hemorrhage into the alveolar spaces. Another outstanding characteristic is the extensive desquamation of the lining of the bronchial tree with aspiration of the desquamated cells into the alveolar spaces. The organisms most frequently found in the lung tissue, bronchial tree and stomach are colon bacilli, gram-positive anaerobic bacilli, diphtheroids, staphylococci, yeasts, steptococci and occasionally pneumococci. Cultures made of tissues within one to two hours after death of persons who have died from non-infectious diseases are almost sterile with the exception of those of the intestinal tract.

A review of the associated pathologic changes suggests some of the more obvious causes leading to aspiration pneumonia: dilatation of the stomach, or obstruction or infarction of the bowel; operations on the stomach and biliary tract; nonsurgical conditions such as cerebral thrombosis or tumor, uremia, meningitis and coma, which obviously lead to abolition of protective reflexes. Hiccup, retching and nausea are more commonly associated with aspiration pneumonia than vomiting. It is believed that the postoperative use of continuous aspiration of the stomach has reduced the incidence of this form of pneumonia.

Clinical studies suggest that a considerable number of nonfatal respiratory complications in patients after operations and in those suffering from other diseases in which there occur eructations and vomiting, or in patients in whom the tracheobronchial reflexes are dulled, are caused

by the aspiration of regurgitated stomach content. Undoubtedly, many of these patients recover, possibly because the aspirated material contains hydrochloric acid and consequently few bacteria.—*S. G. Henderson.*

Steward, W. Dean. Sarcoma of the lung. *Am. Rev. Tuberc.*, August, 1939, *40*, 224–228.

Because of the rarity of primary sarcoma of the lung (except for lymphosarcoma), the author is reporting a case. The patient was a female, aged twelve, admitted to the hospital because of cough, loss of weight and pulmonary hemorrhage. She had been a seven and a half month premature delivery. Four months prior to her entry into the hospital, she had noted the cough and a fever up to 101° F., with progressive loss of weight. Chest studies revealed a circumscribed density in the left upper thorax, with some calcific mottling. In addition there were areas distributed elsewhere which presented the appearance of "old inflammatory" lesions. With rest and supportive treatment, she gained 14 pounds during the next few months. Thereafter, her cough became worse and weakness and anorexia appeared. Mantoux and tuberculin tests were negative. Her temperature varied from 98 to 102° F. Bulging developed in the left anterior thorax and the cough became extreme with expectoration of as much as a half cup of mucoid sputum. Approximately eight months following the first observation, purpuric spots appeared over both thighs and shortly thereafter she died.

The essential findings at autopsy included a mass the size of a grapefruit in the left upper lobe and a smaller mass in the mediastinum. Cut section revealed some calcification, and in the center, a large amount of caseation. Abcesses were found behind and below the mass. Honeycomb cavitation was also found in the other lung. Microscopical studies revealed a loose connective tissue stroma infiltrated with a mixture of spindle cells and small round cells with numerous areas of capillaries and blood spaces—diagnosis: mixed cell sarcoma.—*A. A. de Lorimier.*

Zavod, William A. Tension pneumothorax. *Am. Rev. Tuberc.*, Nov., 1939, *40*, 590–594.

Tension pneumothorax is defined as a pneumothorax which is characterized by a valvular communication between a bronchus and the pleural cavity. It may occur on the basis of trauma, tuberculosis or pulmonary suppuration.

The author is presenting the case of a white male, twenty-four years of age when first studied, who was found to have a tuberculous process in his left lung and who was given artificial pneumotherapy at intervals over a period of more than six years. After a severe coughing spell, he suddenly became dyspneic and cyanotic with rapid, shallow and labored respirations. Though he was decompressed, the thorax became rapidly filled even while the needle was contained. Quantities of 1,500 to 2,000 cc. were aspirated and finally continuous suction was instituted. Coughing was excessive and debilitating. With removal of the suction tube, the dyspnea became extreme and the patient rapidly became worse and died.

Several cavities were found in the right lung and connected to one of these was fistulous tract connecting the pleural cavity to a bronchus which measured approximately 4 mm. in diameter.

Three types of valves are described: the flap, slit and purse-string varieties.—*A. A. de Lorimier.*

Charr, Robert. Spontaneous pneumothorax. *Am. Rev. Tuberc.*, Nov., 1939, *40*, 565–570.

Ten cases of fatal spontaneous pneumothorax are described. All belonged to the third or fourth decades of life. Six were males and 4 females. Eight had pulmonary tuberculosis; 2 anthracosilicosis. In every instance the onset of the pneumothorax was sudden and while the patients were in bed. Coughing, sneezing or any other form of physical exertion did not seem to be associated. The complaints were of dyspnea and pain in the side of the chest involved. All showed cyanosis, clammy skin, weak pulse, dry buccal membranes and apprehension of impending death. In every instance, autopsy revealed that the rupture was either in the anterior or axillary aspects of the lung. Cavities were located in close proximity to the sites of rupture in several instances and pleural adhesions were conspicuous. The author suggests that the absence of ruptures on the posterior aspect of the lungs was due to the fact that excursion of the ribs is greatest at their anterior extremities, especially when one is lying in the supine position. This factor likely explains the bulging of the anterior chest in cases of emphysema and the anterior location of emphysematous blebs and bullae. Sixty per cent of the

ruptures were found on the left side; 40 per cent on the right. The author explains this difference as due to the tugging effect of the heart.

Though tuberculosis is frequently responsible ruptures do occur spontaneously from other causes.—*A. A. de Lorimier.*

GENITOURINARY SYSTEM

FLOCKS, R. H. Calcium urolithiasis: The role of calcium metabolism in the pathogenesis and treatment of calcium urolithiasis. *J. Urol.*, Jan., 1940, *43*, 214–233.

An important relationship has been established between calcium urolithiasis and disturbances of calcium metabolism, such as hyperparathyroidism, bone disease and fractures. Previously the author has demonstrated that high calcium excretion was associated with 66 per cent of cases of calcium urolithiasis; that high calcium excretion was present in all cases of recurrent stones; that among patients with calcium urolithiasis many have a high urinary calcium excretion without bone disease, hyperparathyroidism or changes in the blood calcium and phosphorus; that increased urinary calcium excretion occurred with slight pathological changes in the kidney and decreased urinary calcium excretion with marked pathological kidney changes; and finally, that urinary phosphorus did not show changes corresponding to urinary calcium.

In the normal individual under constant conditions the urinary calcium excretion is remarkably stable. It can be varied by varying the intake of calcium or phosphorus, by varying the acidity of the ash of the diet, and by varying the vitamin D intake. Increases in the intake of calcium and phosphorus, increased acidity of the ash of the diet, and increased vitamin D intake increase the urinary calcium. These variations in the normal individual are small. The following changes in body mechanism produce changes in the urinary calcium which vary markedly from the normal individual: marked body immobilization, intrinsic bone disease, parathyroid, thyroid and pituitary disturbances, intrinsic renal changes and intrinsic variations in individuals. Prolonged immobilization in bed leads to bone decalcification and increased urinary calcium. In bone disease there is an increased urinary calcium due to the disease itself, changes secondary to injury and repair of bone or immobilization of the skeleton. A marked increase of urinary calcium occurs in hyperparathyroidism, associated with hypercalcemia and hypophosphatemia. Some investigators have shown that renal calculi occur in 70 per cent of cases of hyperparathyroidism. Albright has shown that increased calcium excretion occurs in some cases of hyperthyroidism. With marked kidney damage a low fixed urinary calcium is found regardless of calcium intake. Finally there is a large group of individuals with a high calcium excretion for which no cause can be found.

The author considers the management of calcium urolithiasis from three aspects: the prophylaxis of calculi in the presence of high urinary calcium, the management of patients with calcium urolithiasis and high urinary calcium, and the management of patients with calcium urolithiasis and normal or low urinary calcium. In the case of patients who are subject to prolonged immobilization in bed he recommends forcing of fluids to dilute the urinary calcium, a low calcium and phosphorus intake, avoidance of acid ash diet and vitamin D intake, avoidance of urinary tract infection, and finally, when the urinary calcium returns to normal, after immobilization has been discontinued, increased fluid intake and acidification of the urine.

In the management of patients with calcium urolithiasis and a high urinary calcium, an attempt should be made to find causes such as parathyroid adenomas, bone disease or other endocrine disturbances. If such causes cannot be found the principles of treatment outlined previously should be followed.

In the final group with urolithiasis and normal or low urinary calcium, an acid ash diet is indicated if the low urinary calcium is not due to poor kidney function. Fluids should also be forced. The intake of calcium and phosphorus is not important.—*R. M. Harvey.*

OSTRUM, H. W., and FETTER, J. S. Silent nephroma. *J. Urol.*, Jan., 1940, *43*, 39–51.

The above title was given to a group of advanced renal neoplasms with extensive metastases which, in the absence of signs and symptoms of urinary tract disease, led clinicians to suspect disease in structures other than the kidneys. The authors report 21 cases most of which were referred for roentgen study of some other system than the urinary tract. All cases have been proven histologically. Pain, hema-

turia and tumor are apt to be late signs of renal cancer. In the cases reported the disease was far advanced but the complaints of the patients were all referred to metastatic sites and not to the primary disease. Some cases had mild urinary symptoms but not sufficient to divert attention from the metastatic sites. Hematuria was present in only 3 cases. Among the presenting complaints were "cold" of ten months' duration, acute arthritis, acute abdomen, abdominal pain of varying severity, pains in the shoulder, neck, and back, tuberculosis and loss of weight and strength. Abdominal tumor mass was felt clinically in 10 of the 21 cases. Two cases displayed destructive bone lesions which were indistinguishable roentgenologically from osteogenic sarcoma. In one case a diagnosis of acute rheumatic fever had been made before admission to the hospital. Only a few of the cases were in sufficiently good physical condition to warrant radiation therapy. In those who were treated some received palliation. The authors have found, in line with reports of other investigators, that in some cases of renal cancer operation becomes possible following preliminary irradiation.—*R. M. Harvey.*

Maslow, L. A. Wilms tumor: Report of three cases and a possible fourth one in the same family. *J. Urol.*, Jan., 1940, *43*, 75–81.

A familial tendency to Wilms' tumor has been suggested in the literature but according to the author no previous proved case has been reported. He reports 3 proved cases which were operated on in a single family and a fourth case in which the diagnosis seemed likely but was not verified by operation. Their ages ranged from seventeen months to four years. One child received no treatment, one was operated on for ileus and an inoperable tumor found, the third had a nephrectomy and postoperative irradiation and the fourth pre- and postoperative irradiation as well as nephrectomy. All patients died within six months after diagnosis was made. No hereditary disposition was noted. There is a definite congenital predisposition plus some added controlling element which determines the time at which the cells begin to proliferate.—*R. M. Harvey.*

Kereszturi, Camille. Imperforate hymen causing hydrocolpos, hydroureter, hydronephrosis and pyuria. *Am. J. Dis. Child.*, June, 1940, *59*, 1290–1297.

Only 7 cases were found in the literature of hydrocolpos associated with imperforate hymen causing symptoms before puberty. In the case reported in this paper, an imperforate hymen caused hydrocolpos in early infancy, and this in turn, through pressure on the urinary tract, led to bilateral hydroureter and hydronephrosis, pyuria and bacilluria.

Roentgenographic study showed the colon was displaced upward when the patient was two months old. Intravenous urograms revealed bilateral hydroureter and bilateral hydronephrosis with obstruction of the ureters at the ureterovesical junction. The bladder was large and was situated in the lower part of the abdomen. A laparotomy was performed when the patient was ten weeks old. A cystic tumor was found which almost filled the pelvis, pushing the bladder and the uterus upward and forward. Pressure on this mass caused bulging of the hymen. Before the abdomen was closed, the hymen was incised with release of about 2 ounces of milky fluid, whereupon the pelvic tumor collapsed. Bacterial study of this vaginal fluid yielded no growth.

After operation decrease in the dilatation of the renal pelves and the ureters occurred. At twenty-two months of age the child was readmitted for a profuse vaginal discharge which cleared up on treatment with sulfanilamide. The intravenous urogram showed no pathologic condition.—*R. S. Bromer.*

SKELETAL SYSTEM

Kushner, Alexander. Evaluation of Wolff's law of bone formation. *J. Bone & Joint Surg.*, July, 1940, *22*, 589–596.

Wolff, in 1870, depicted the structure of bone as representing an exact symbol of external forces which were operative upon it and formulated his "Law of Transformation of Bone," in 1892, which stated that wherever stresses of pressure and tension are caused in bone, be it by pressing forces or pulling, formation of bone takes place. Jansen objected strongly to this principle and advanced many arguments to show that Wolff's deductions were fallacious and that tension will result in atrophy of bone, whereas pressure constitutes the only trophic stimulus. His deductions were based on a study of bone trabeculae of sections of normal and pathological bone taken from parts of the skeleton where stress is greatest. He concluded that

tension is unfavorable to bone growth, and that the bone elements place or displace themselves in the direction of functional pressure. He also stated that wherever bone formation is to be promoted, as in fractures and bone transplants, it cannot be expected, on any reasonable ground, from tension although it can be anticipated from pressure.

Kushner cites clinical evidence in support of Wolff's law as originally propounded. He believes that Jansen's contention that tension always produces bone atrophy is not substantiated, and his proposal that Wolff's law be modified accordingly is unwarranted. He states that a bone graft will survive and will continue to hypertrophy, although under constant tension.—*R. S. Bromer.*

CARRELL, W. B., and CHILDRESS, HAROLD M. Tuberculosis of the large long bones of the extremities. *J. Bone & Joint Surg.*, July, 1940, *22*, 569–588.

Tuberculosis of the large long bones is rare in the United States. The authors sent a questionnaire to 250 leading orthopedic surgeons in the United States and Canada and 74 cases were reported. Their paper is a discussion of these cases, together with a report of 4 new ones and a detailed study of an unusual case with multiple tuberculoid lesions. In the last case a differential diagnosis included syphilis, pyogenic osteomyelitis, coccidioidal infection, Jüngling's disease and Boeck's sarcoid. The roentgenographic appearance was in accord with three distinct types of tuberculous lesions. The encysted form showed definite cystic formation in the metaphysis with but slight bone reaction. The atrophic form had marked metaphyseal bone atrophy and expansion, the latter being due to an excess of periosteal bone formation, which had been undermined by the disease process. The infiltrating type was marked by periosteal reaction, sclerosis of bone, and extensive shaft involvement. During the three years in which this patient with multiple lesions was under observation, the diagnosis of tuberculosis was not confirmed by pathological study, guinea-pig inoculations and the Mantoux test. The history and clinical behavior of the bone lesions in both the diaphyses and the metaphyses have been consistent with those of tuberculosis.

The following conclusions are given by the authors:

1. Shaft tuberculosis is essentially a chronic disease. In rare instances it may be fulminating and rapidly progressive.

2. The tubercle bacillus does not have a predilection for the growing bones of children, since, in nearly one-half of the cases reviewed, the disease started in patients over twenty years of age.

3. Of the large long bones, the tibia and the femur are most frequently affected.

4. Active pulmonary and other tuberculous lesions are frequently associated with shaft tuberculosis.

5. The treatment most frequently used was incision and drainage, due, in part, to early diagnosis of pyogenic osteomyelitis.

6. Saucerization and packing is an effective treatment in the presence of draining sinuses.

7. Curettage or saucerization and closure in cases without sinuses, practically and theoretically, is the treatment of choice in tuberculosis of the long bones of the extremities.—*R. S. Bromer.*

WEAVER, JAMES B., and FRANCISCO, C. B. Pseudofractures. A manifestation of nonsuppurative osteomyelitis. *J. Bone & Joint Surg.*, July, 1940, *22*, 610–615.

Roberts and Vogt have recently reported 12 cases of a new clinical entity to which they have given the name of pseudofracture of the tibia. This condition is described as a lesion occurring in the upper third of one or both tibiae and characterized in the roentgenogram by a localized area of periosteal thickening and new-bone formation over what appears to be an incomplete V-shaped fracture of the cortex.

The authors report 3 cases which illustrate this condition and demonstrate that it is not confined to children and that bones other than the tibia may be affected. They believe that the history, physical findings and progress of the lesions in their patients conflict in no way with a definite histological picture of infection, and they are convinced that the so-called pseudofractures of Roberts and Vogt are a type of nonsuppurative osteomyelitis. A causative organism was not found. However, the fact that in 2 of the cases, no staphylococcus antitoxin was found in the blood is some evidence, if not proof, that the staphylococcus was not at fault. In their limited experience they find that decompression of the affected bone promotes more

rapid healing and prompt alleviation of symptoms.—*R. S. Bromer.*

Jaffe, Henry L., and Lichtenstein, Louis. Osteoid-osteoma: Further experience with this benign tumor of bone, with special reference to cases showing the lesion in relation to shaft cortices and commonly misclassified as instances of sclerosing non-suppurative osteomyelitis or cortical-bone abscess. *J. Bone & Joint Surg.*, July, 1940, *22*, 645–682.

On the basis of additional experience the condition which Jaffe described in 1935 under the name of osteoid-osteoma is again considered by the authors. Including the 5 cases originally described, their total experience with the condition now covers 33 cases. In the present paper they have drawn on this total experience for the statistics and the general sections on the clinical, roentgenographic, pathological and therapeutic findings. In addition, this paper records details on 8 cases, not including any already described in the original paper, which have been selected to convey a well-rounded picture of the condition as it is encountered in individual instances.

Their thesis is that osteoid-osteoma constitutes a lesion sui generis and specifically is a distinctive benign tumor appearing in bones. It is always a small lesion affecting a single bone. It may develop in the spongiosa or in the cortex of the affected bone, and it stands out from the surrounding osseous tissue as sharply delimited nidus. The latter is usually composed of osteoid and more or less calcified atypical new bone, which can be seen to have developed out of a rather vascular osteogenic connective tissue. From the findings in their series of cases, an osteoid-osteoma seems to run the following histogenic course: It appears to pass from (1) an initial stage, in which actively proliferating and compacted osteoblasts may be prominent, through (2) an intermediate phase, in which osteoid in various stages of calcification is conspicuous, to (3) the mature stage, in which the prominent feature of the lesion is the presence of densified trabeculae of highly calcified atypical bone. When an osteoid-osteoma develops in spongiosa a narrow or even fairly wide zone of the surrounding spongy osseous tissue usually becomes densified and sclerotic; if an osteoid-osteoma develops in the cortex, the latter, too, tends to become thickened, mainly through periosteal new bone deposition. In fact, if the lesion develops in the cortex of a long bone, as it not infrequently does, the reactive cortical thickening may be very striking.

Thus, in interpreting the roentgenographic picture in a case of osteoid-osteoma, the authors draw attention to two aspects of the picture—the manifestation of the osteoid-osteoma proper and that of the reaction which it has incited in the surrounding tissue. The osteoid-osteoma proper is usually indicated roentgenographically by a relatively radiolucent or rarefied area, although, if it has become substantially ossified, it may appear as a relatively radiopaque nidus. In the cortex of a long bone, one may have difficulty in distinguishing the osteoid-osteoma shadow if the reactive cortical thickening is considerable or if the lesion has become ossified, since its shadow may be dominated by that of the thickened cortex. In any event, because the roentgenographic picture has these two aspects, a case of osteoid-osteoma in a spongy-bone area is commonly mislabeled chronic osteomyelitis with a bone abscess or with an annular sequestrum, the label depending upon the extent to which the osteoid-osteoma had undergone ossification. A case of osteoid-osteoma in the shaft of a long bone is commonly mislabeled sclerotic non-suppurative osteomyelitis of Garré or intracortical bone abscess, the latter diagnosis tending to be made especially when the rarefaction shadow in the cortex is very distinct and the cortical thickening is not very pronounced.

Clinically, the authors state it is a striking fact that the disorder has a predilection for young adolescents and young adults, principally between the ages of ten and twenty-five. The presenting symptom is localized pain, usually of at least several months' duration, which may be persistent and severe enough to wake the patient at night. They emphasize that the clinical findings do not point to an infectious inflammatory origin for the disorder, although, in the past, surgeons, like roentgenologists, have usually interpreted the combined clinical and roentgenological pictures in these cases as indicating such an origin. As to treatment, surgical excision of the osteoid-osteoma proper with some of the surrounding bone was the procedure used in their cases. It resulted in clinical cure with prompt and often dramatic relief of distressing pain. In their experience of seven years, no recurrence has been noted in any of the patients.—*R. S. Bromer.*

FRANCIS, CARL C. Factors influencing appearance of centers of ossification during early childhood. II. A comparative study of degree of epiphysial ossification in infancy under varying conditions of diet and health. *Am. J. Dis. Child.*, May, 1940, *59*, 1006–1012.

This paper presents the results of a group study of the effect on epiphysial ossification of disturbances of health during the first year of life and also of the effect of certain variations in diet during the same period. Francis states that epiphysial ossification is not to be confused with skeletal maturity.

Francis concludes that epiphysial ossification is a more delicate indicator of constitutional health than is progress in height or weight. Gastrointestinal sensitivity in infancy, even when so well controlled that there is no retardation of growth in length, nevertheless tends to retard epiphysial ossification. In healthy children the degree of epiphysial ossification is influenced by the amount of mineral available in the diet. Severe or prolonged illness holds back the general progress, but epiphysial ossification shows the greatest retardation. The advance in precocity of the female child over the male child in epiphysial ossification disappears in severe prolonged illness. The failure of the number of centers ossified in the female cadavers to remain in advance of the male suggests that the precocity seen in living female babies is not due to sex alone.—*R. S. Bromer.*

SELIG, SETH, and SCHEIN, ALBERT J. Irreducible buttonhole dislocations of the fingers. *J. Bone & Joint Surg.*, April, 1940, *22*, 436–441.

Dislocations of the phalanges of the fingers are exceedingly common and can usually be reduced by simple traction applied through the terminal phalanx. Clinically, it is occasionally difficult to determine whether reduction has been complete. Even though the bones are directly subcutaneous, the edema and accompanying tenderness mask the true state of affairs unless the examination is very careful and painstaking. Occasionally traction fails to reduce the dislocation and, unless the condition is promptly recognized and corrected, there will be almost complete loss of motion at the involved joint.

The anatomy of the region accounts for the difficulty that is occasionally encountered in reducing the palmar dislocation of the middle and proximal phalanges. The distal end of the more proximal phalanx is forced through a buttonhole tear in the glenoid ligament, which is really a thickened portion of the anterior capsule of the joint. The buttonhole tightly hugs the narrow portion of the phalanx immediately behind the head and prevents closed reduction. Occasionally a fold of the dorsal extensor aponeurosis also becomes caught between the bone ends and prevents reduction. If the dorsal aponeurotic fold is not removed from between the bone ends, the dislocation can be almost, but not completely, reduced and will recur as soon as the powerful traction of the reducing force is removed.

If the roentgenogram reveals that the reduction is not complete after traction has been applied, the authors state an attempt at closed reduction should be made under anesthesia, and, if unsuccessful, the dislocation should be exposed by open operation and reduced. If the circulation of the fingertip is compromised, especially in compound dislocations, it is wiser to use general rather local-block anesthesia to avoid even the remote danger of gangrene. Because of the poor results that follow delay, it is unwise to wait for healing of a compound dislocation before proceeding with operative reduction. One should carefully debride the wound and run the risk of infection that may follow immediate operative reduction.—*R. S. Bromer.*

BOGAN, ISABEL K. Hands and wrists of the diabetic child. A roentgenologic study. *Am. J. Dis. Child.*, April, 1940, *59*, 805–815.

This study was undertaken primarily to obtain data concerning the osseous ages of a group of diabetic children, to observe the variations from the chronologic ages and the incidence of anomalies and developmental defects. Roentgenograms of the hands and wrists of 95 boys and of 74 girls were assessed by Todd's and Flory's standards to ascertain the osseous ages. Anomalies and development defects were noted.

The osseous and chronologic ages were found to be the same or to vary up to six months, plus or minus, for 25.9 per cent of the boys and 33.2 per cent of the girls. The osseous ages were retarded for 60.2 per cent of the boys and 51.1 per cent of the girls and were accelerated for 13.8 per cent of the boys and 15.6 per cent of the girls.

Twenty and seven-tenths per cent of the

children were found to have retardation of osseous growth of more than two years, and 13.6 per cent had retardation of more than three years. The incidence of boys showing retardation was greater than that of girls. In the subjects studied, the longer the duration of diabetes, the greater was the tendency to retardation. Among persons with diabetes of the same duration, the average age of children with retardation was greater than of those with normal or accelerated osseous growth. Anomalies and developmental defects were observed in one-fourth of the diabetic children.

The author concludes that anomalies and developmental defects occur more frequently in the diabetic than in the non-diabetic child. The high incidence (20.7 per cent) of retardation of more than two years in the children studied and the retardation of all boys with diabetes of more than thirteen years' duration and of all girls with diabetes of more than nine years' duration, suggest that diabetes mellitus plays some part in the delayed development.—*R. S. Bromer.*

GRAZIANI, ALDO. L'esame radiologico del carpo. (Roentgen examination of the wrist.) *Radiol. med.*, May, 1940, *27*, 382–392.

Generally examinations of the wrist are made in the dorso-palmar and radio-ulnar projections and an attempt at accuracy is made by comparing the roentgenograms of the two sides. This often does not give satisfactory results, however, because of superposition of the shadows of the bones so that details are not clear. As a means of obtaining greater clearness and projecting the different bones outside the shadows of the others the author proposes making the three following groups of projections: (1) dorso-palmar and palmo-dorsal; (2) radio-ulnar and ulno-radial; (3) oblique palmo-cubital, oblique dorso-cubital, oblique palmo-radial, oblique dorso-radial. Photographs of the hand in these positions and roentgenograms showing details of the pictures obtained are given and a detailed explanation of the way in which different bones are cleared from the shadows of the other bones so that definite pictures of pathological lesions may be obtained.—*Audrey G. Morgan.*

ANDERSON, RANDOLPH L. Isolated tuberculosis of the spinous process of a vertebra. *J. Bone & Joint Surg.*, July, 1940, *22*, 741–744.

The anterior portion of the vertebral body is the part usually involved in tuberculosis of the spine, and at times the disease spreads to the pedicles and the laminae, but rarely affects the spinous processes. For this reason, Anderson reports a case of isolated tuberculosis of the spinous process of the fourth lumbar vertebra.

He thoroughly reviewed the literature and found that 12 cases in which the spinous process of the vertebra alone was involved have been reported in the foreign literature and that no cases have been recorded in the American literature. A single vertebra was involved in 7 cases and two vertebrae were affected in 5 cases. Five other cases of involvement of the posterior parts of the arch of the vertebra—the transverse processes, the laminae, or the articular processes—were reported. He found only 30 new cases in which the posterior portion of the vertebra alone was affected with no involvement of the body.

The first symptoms of tuberculosis of the spinous process of a vertebra is pain, and this is followed after a variable period by an abscess. Often there is no muscle spasm. The diagnosis is made from the presence of pain and an abscess, a positive Mantoux test, and the roentgenographic findings. No gibbus or paraplegia is present when the process alone is involved. These lesions are less common and less grave than lesions of the bodies of the vertebrae. This type of tuberculosis is relatively more frequent in adults than in children.—*R. S. Bromer.*

WILSON, MILTON J., MICHELE, ARTHUR A., and JACOBSON, EDWIN W. Spontaneous dislocation of the atlanto-axial articulation, including a report of a case with quadriplegia. *J. Bone & Joint Surg.*, July, 1940, *22*, 698–707.

The authors collected 28 cases of spontaneous dislocation of the atlanto-axial joint, not complicated by fracture or by organic disease of the vertebrae and report one case of their own. The sex incidence is equally divided and the age incidence ranges from two to sixty-two years, with the greatest peak in childhood.

The dislocation is preceded by an antecedent infection, most often of the nose and throat, but which may be one of the exanthemata, rheumatic fever, or mastoiditis. Their case was unique in that the patient was an adult of sixty-two in whom there had developed a complete quadriplegia amenable to treatment. The

post-reduction roentgenograms showed a good reduction, and a two-year follow-up revealed that there had been no recurrence.

Head traction is considered by the authors the best method of reduction and should be followed by a plaster or Thomas collar.

Of the many theories offered as a cause of the condition, that of Berkheiser and Seidler is considered by the authors as the most logical, namely, effusion into the joint capsule with overdistention of the ligaments. However, they call attention to one factor which appears to be overlooked—that is, the probability of an intrinsic factor in the vertebrae. Many people have respiratory infections each winter, yet the incidence of spontaneous dislocation of the atlas is comparatively rare. Adequate postmortem examination would settle this point. In the absence of this evidence, however, they state a satisfactory explanation of the pathological process behind the disease must remain lacking. —*R. S. Bromer.*

DIETRICH, HARRY F. Tetanus in childhood, with special reference to treatment. *Am. J. Dis. Child.*, April, 1940, *59*, 693–710.

Dietrich reviews in this paper a series of 28 cases of tetanus in children. He concludes that 1,500 units of tetanus antitoxin does not afford adequate prophylaxis in cases with compound fractures. Compression deformities of the dorsal vertebrae constitute a common deformity and were found in over 60 per cent of his cases. Moderate doses of serum are, he states, theoretically adequate in the treatment of tetanus but intrathecal administration of serum is theoretically unsound and practically is dangerous in treating the condition in children. Intravenous administration of serum may cause fatal reactions, but a single dose is theoretically advantageous. Intramuscular administration of antitoxin is completely safe, and by itself is adequate, except possibly when the tetanus is most severe. Except during the course of reactions to serum administered intravenously and intrathecally, sedatives are safe, highly desirable in large doses, and frequently lifesaving.—*R. S. Bromer.*

BENASSI, ENRICO. Ossificazioni locali del legamento vertebrale comune. (Local ossifications of the common vertebral ligament.) *Radiol. med.*, June, 1940, *27*, 471–474.

The author describes 2 cases in which there was an ossification of the lateral fibers of the longitudinal ligament of the spinal cord. The ossifications extended over only one intervertebral disc and were unilateral in both cases. The first case was in a man of twenty-seven who came for examination for colitis and had no symptoms referable to the spinal column. The bone process began on the edge of the first lumbar vertebra and extended down over the intervertebral disc to end in a free blunt end near the upper part of the vertebra below. It was obviously an ossification of the ligament and not an osteophyte. No cause for it could be found.

The second case was in a man of fifty-five who had been injured in the war. A bullet had lodged in the spongy part of the twelfth dorsal vertebra. The patient complained of some local pain in the trunk and came for examination in connection with his pension. In this case the ossification began at the upper rim of the twelfth lumbar vertebra and passed upward over the intervening intervertebral disc to end at about the middle of the eleventh lumbar vertebra in a free blunt end as in the other case.

These ossifications of the longitudinal vertebral ligament are probably generally either post-traumatic or peri-arthritic.—*Audrey G. Morgan.*

KROGDAHL, TRYGVE, and TORGERSEN, OLAV. Die "Unco-Vertebralgelenke" und die "Arthrosis deformans unco-vertebralis." (The unco-vertebral joints and unco-vertebral arthrosis deformans.) *Acta radiol.*, 1940, *21*, 231–262.

The cervical vertebrae have a transversely concave form due to the presence at the ends of the bodies of a process that runs almost vertically upward. Trolard named this the processus uncinatus. The joints which Luschka calls hemiarthroses intervertebrales laterales and Trolard calls unco-vertebral joints are formed by an articulation between these processes and a small joint surface which lies on the lower lateral side of the vertebra next above. The changes of deforming spondylosis do not lie farther back than the edge of the anterior longitudinal ligament, but the exostoses formed in inflammation of these unco-vertebral joints lie farther back than this, laterally and posterolaterally from the bodies of the vertebrae. They are apparently caused by an unco-vertebral arthrosis deformans.

These exostoses can be demonstrated roentgenologically and the author has made a study of them in 10 cases. They are found particularly in the caudal part of the cervical spinal column. The oblique projection is particularly useful in giving clear pictures of these exostoses. If they lie far back they may partially obstruct the intervertebral foramen and if farther forward may limit the lumen of the vertebral canal.

Their clinical importance lies in their close relationship to the spinal nerves. They may narrow the opening and exercise pressure on the spinal nerve roots. When they are farther forward and affect the spinal canal and its contents they may produce Barré's syndrome, due to lesions of the cervical sympathetic, particularly the vertebral nerve. This syndrome consists of headache of varying types, particularly occipital. Often the headache is accompanied by pressure behind the eyes and vasomotor disturbances in the head and face, as well as paresthesias of varying intensity and extent. Very frequently there is dizziness, generally of the rotatory type, and buzzing and pain in the ears. There is sometimes a pharyngeal syndrome characterized by paresthesias of the pharynx, dysphonia and difficulty in swallowing.—*Audrey G. Morgan.*

Zander, Göran. Case of osteogenesis imperfecta tarda with platyspondylysis. *Acta radiol.*, 1940, *21*, 53–61.

There are two forms of osteogenesis imperfecta, the congenital form in which the symptoms are present at birth and the late form in which the changes do not appear until the child is a year or more old.

A case is described in a boy eight years of age who developed normally until about a year old when he suffered his first fracture. Since then he has had repeated fractures, 23 in all. He has had diabetes since the age of three and has been on insulin. There is no known history of malformations in the family.

On roentgen examination the bones showed very slight contrast. The skull was large and hydrocephalic in appearance, the bones of the skull thin. The bodies of the vertebrae, particularly those from the fifth dorsal to the first lumbar, were thinner than normal and biconcave. The intervertebral discs were biconvex and broader than normal vertically. The biconcave shape of the vertebrae is caused by decreased resistance to the normal elasticity of the intervertebral discs. It is possible, however, that the malformation of the vertebrae may be due to disturbances of embryonic development.

The various theories in regard to the causes of osteogenesis imperfecta are discussed. None of them has been proved definitely. In this case it is probable that the decreased resistance of the bones led to the changes being most marked in the lower dorsal and upper lumbar vertebrae which are especially subject to mechanical injuries.

The author had an opportunity to examine the patient ten months later when he was sent in for a fracture of the femur; the thinning and biconcavity of the bodies of the vertebrae had increased considerably.—*Audrey G. Morgan.*

Conley, Arthur H., and Miller, Donald S. Atrophic Charcot's hips. *J. Bone & Joint Surg.*, July, 1940, *22*, 638–644.

The incidence of the atrophic variety of Charcot's hips is not as uncommon as one would suppose. The authors report 5 cases which occurred within a relatively short period of time. The diagnosis must be considered when there is a triad of symptoms associated with an increased mobility of the joint and a positive blood or spinal fluid Wassermann reaction. In all their patients the joints were painless and roentgenograms revealed a characteristic loss of bone substance and diminished reaction rather than the proliferative, irregular deposit of the hypertrophic type.

The treatment to date has been very unsatisfactory, although the administration of heavy metals should be tried. Surgery was not of any assistance in their single case and is not advised except in certain isolated cases, particularly when diagnosed very early. The prognosis for recovery, as well as for function of the joint, is poor.—*R. S. Bromer.*

Godoy Moreira, F. E. A special stud-bolt screw for fixation of fractures of the neck of the femur. *J. Bone & Joint Surg.*, July, 1940, *22*, 683–697.

Godoy Moreira describes a new method for fixation of fractures of the neck of the femur. A stud-bolt with a very sharp and high helicoid thread is used. The thread takes hold only in the head of the femur. The screw is cannulated, so that it may be guided by a Kirschner wire previously inserted. He also uses an electric drill which is likewise cannulated which has the great advantage of perforating the head and

neck very smoothly. In this manner, the separation or turning of the head and neck while the channel is being made is avoided. No hammering is required and the operation, he claims, produces minimal trauma. As the head of the femur is so firmly held against the neck that it amounts to impaction, no rotation or flexion can take place at the site of fracture. The weak point of most of the methods previously in use had been the lack of this firm anchorage of the head of the femur.

The technique also dispenses with the application of a cast. Patients are allowed to sit up in bed on the day of the operation. Eight of the author's patients were permitted to walk without a cast from nine to twenty days after operation. Roentgenograms taken thereafter showed no evidence of movement of the fragments. Active motion should be instituted from the beginning. Godoy Moreira states that the screw has been always well tolerated, and up to the present he has never had to operate for extraction of the screw.—*R. S. Bromer.*

WILSON, JOHN C. Fractures of the neck of the femur in childhood. *J. Bone & Joint Surg.*, July, 1940, *22*, 531–546.

The incidence of fractures of the neck of the femur in childhood is not great. There were two fractures of the neck of the femur in children among 600 fractures of the upper end of the femur treated at the Los Angeles General Hospital in the last ten years. Wilson has seen ten such fractures in children and reports the results of his treatment. He concludes that fractures of the neck of the femur in childhood are serious injuries. Maintenance of reduction in the Whitman cast is difficult. Perhaps a nail would be more effective but damage in such case to the epiphyseal plate must be considered. Changes in growth are to be expected. The disturbances of growth which Wilson encountered did not conform to the classic picture of Legg-Calvé-Perthes' disease. Oblique subtrochanteric osteotomy is helpful in bringing a limited arc of motion into useful planes. In some of the patients, a badly deformed but revascularized head and neck of the femur were shown by roentgenographic examination as end-results, several years after the original injury.—*R. S. Bromer.*

RAUCH, SOLOMON. Transitory synovitis of the hip joint in children. *Am. J. Dis. Child.*, June, 1940, *59*, 1245–1265.

Anomalies of the hip joint in children are common enough to warrant a better understanding of them by the general practitioner and pediatrician. Rauch regards this as especially true of one of the benign forms, to which the term transitory synovitis of the hip joint has been applied. This condition has come to be regarded as a nonspecific, relatively transient inflammation of the synovial membrane of the hip joint of a child. The onset may be acute or insidious. Clinically, there are symptoms of pain, limp or unwillingness to walk and signs chiefly of restriction of hip motion. Laboratory evidence of infection (fever, leukocytosis, rapid erythrocyte sedimentation) is usually lacking but may be present. The intradermal tuberculin reaction is, with an occasional exception, negative, and the roentgenogram of the hip joint invariably so. The treatment is conservative and the prognosis for functional recovery excellent.

The cases of acute transient epiphysitis of the hip joint described by Miller in 1931 must be differentiated. In this condition, even though first roentgenograms may show no pathologic signs, at some time during the period of observation changes in bone texture or joint outline, localized abscesses or areas of absorption along the epiphysial line in the femoral head or neck become manifest. The roentgenograms in instances of transitory synovitis repeatedly show normal conditions. One can reconcile, then, the possibility of the existence of these two conditions side by side without assuming that in cases of synovitis changes are not seen in the roentgenograms either because the roentgenograms are erroneously misinterpreted or because the lesions had healed and become undetectable at the time the roentgenograms were made.

Rauch presents and analyzes 37 cases of transitory synovitis of the hip joint in children which were observed for two and one-half years. He reviews closely related anomalies of the hip joint which have been previously reported and emphasizes their pathologic and roentgenographic differences. He describes the technique of an adequate examination of the hip joint and discusses the question of the relationship of allergy to transitory synovitis. The importance of roentgenographic study and interpretation and of other laboratory aids is stressed. He suggests a program in detail of management of any child with complaints referable to the lower extremities.—*R. S. Bromer.*

Parere, Vincenzo. Osteo-distrofia bilaterale del collo femorale. (Bilateral osteodystrophy of the neck of the femur.) *Radiol. med.*, June, 1940, *27*, 452–465.

The author discusses the various juvenile dystrophies of the epiphyses and points out that Perthes' disease, Köhler's disease, Osgood-Schlatter's disease, Kienböck's disease, etc., are only different names applied to the same disease in different locations. To be sure there are some differences in these diseases, due to the different bones in which they are located, but from the clinical point of view they are all localized in the epiphyses in children of the same age, they begin gradually, develop slowly and recover spontaneously. The essential anatomical fact shown by roentgen examination is necrosis of the spongiosa of the affected epiphysis, with absorption of bone tissue and substitution of fibrous tissue. There are also circulatory disturbances which may be the cause of the bone necrosis.

The author describes a case which differs in some points from all these but probably belongs somewhere in this group. The patient, a boy born February 4, 1932, suffered a severe septic bronchopneumonia at the age of two, following measles and bilateral purulent otitis. Suddenly in April, 1937, he began to have severe pain in the right hip and limped badly. The right leg turned outward on walking. He was put at rest in bed for a month followed by relative rest for some months and recovered so that he could walk without pain, but the external rotation of both knees and feet persisted.

The roentgen findings at the age of five, six and seven years are reported in detail. On the first examination the upper epiphysis of the right femur showed diffuse osteoporosis, while that on the left was densely opaque. The neck of the femur on the left was shortened and thickened with a process at the top which resembled a bird's beak. The head and neck appeared to be fused and formed a single mass without any boundary line between them. On the right the appearance was much more nearly normal. At the succeeding examinations the bone structure gradually approached more nearly to normal.

In discussing the cause of this condition the author excludes tuberculosis, syphilis, acute and chronic osteomyelitis, the circumscribed form of fibrous cystic osteodystrophy and myxedema and concludes that the case belongs among the osteodystrophies of the growth years. The fact that the clinical signs were worst on the side that showed the least roentgen change may have been due to the fact that the disease had persisted for a long time before it became manifest clinically and there had been a consistent effort to spare the most seriously diseased side. It is quite probable that the disease was initiated by a toxic infection from the severe illness at the end of the second year and it may be possible also that there was a certain degree of chronic rickets. The child was delicate and of lymphatic constitution with a tendency to exudative phenomena and lack of calcium. Mild chronic rickets may be a factor in the etiology of juvenile osteodystrophies in general.—*Audrey G. Morgan.*

Lindblom, Knut. Roentgenographic symptoms of meniscal lesion in the knee joint. *Acta radiol.*, 1940, *21*, 274–285.

Direct roentgen examination of the knee joint for lesions has not been much used since the introduction of arthrography. The injection of a contrast medium for this purpose was introduced as early as 1905 but it did not come into general use until the past decade. Various contrast media have been used and there is no special objection to any of them except iodized oils and thorotrast.

The author's material consists of 74 cases arthographed during 1938–1939 at Åsö Hospital and one case from St. Erik's Hospital. In 43 of the cases the diagnosis was lesions of the meniscus. Among the 27 cases operated on the arthrographic diagnosis was confirmed in 25. For the study of the changes seen on direct examination the same material was used and also 156 cases in which no arthrographic examination was made, but frontal pictures of both knee joints were taken. In every case of knee joint complaint frontal views were taken of both knees and lateral views of one or both knees. When the arthrographic examination was made stereoscopic roentgenograms were taken with the knees both extended and flexed. With the knee extended the usual frontodorsal views were taken and oblique views with the leg in external and internal rotation. With the knee flexed lateral and dorsofrontal views were taken. The arthrograms are reproduced.

Before the arthrography any exudate was pressed out. Then about 9 cc. of 35 per cent perabrodil was used. After the injection move-

ments of the knee joint were made to spread the contrast medium. A circular compressing bandage was then applied, especially over the suprapatellar recess. The roentgen examination was made as quickly as possible because of the rapid absorption of the contrast medium. After the examination the patient was told to be as careful as possible with the knee for the rest of the day. There were no complications except in a few cases a slight dull ache the first quarter to half hour after the injection or a little exudate for the first twenty-four hours. Such exudates were probably caused by lesions of the capsule by the needle rather than by injection of the contrast fluid.

The symptoms of lesions of the meniscus shown in the arthrogram were: (1) contrast filling of a fissure in 35 cases; (2) partial defect of the meniscus in 10 cases, and (3) interposition of pathologic soft tissues between the condyles in 2 cases. There was a combination of different symptoms in 4 cases.

In cases in which there were lesions of the meniscus there were roentgen signs of arthrosis on the affected side. As a rule the arthrosis was confined to or more pronounced on the side of the lesions of the meniscus. In early cases the change consisted only of an osteophyte on the tibial condyle, either in or immediately below the edge of the cartilage. Careful comparison with the normal side had to be made to detect such osteophytes. In chronic cases there were osteophytes on both the tibia and femur and sometimes also decrease of the height of the joint cartilage and subchondral sclerosis.

Study of the histories showed that as a rule osteophytes did not appear until a few months or years after the injury to the meniscus. In 2 cases, however, they appeared as soon as three weeks after the trauma. Fissures of the meniscus are very important in arthrographic diagnosis.—*Audrey G. Morgan.*

SKINNER, HOMER L. Unusual tarsal injuries. *J. Bone & Joint Surg.*, April, 1940, *22*, 421–424.

In reviewing the literature, Skinner found that the terminology of tarsal injuries was somewhat confusing. He believes that the term, "mediotarsal" dislocation, should be applied to those cases only in which it can be demonstrated that both the calcaneocuboid and the astragalonavicular joints have been luxated, while the other tarsal and metatarsal joints bear their normal relationship to each other. The term "subastragaloid" should be reserved for those cases in which the astragalocalcaneal ligaments, as well as one or both of the mediotarsal ligaments have been torn, but in which the tibiotarsal ligaments have remained intact. Isolated dislocations should be considered as a separate type rather than as partial mediotarsal dislocations.

The exact mechanism in dislocations of the astragalus and in mediotarsal injuries is rather vague. Since the astragalus is the key bone about which all important motions of the tarsus center, Milch believes that one can better understand the type of injury if the astragalus is considered the active force instead of regarding the forefoot as the prime factor. In dislocation of the astragalus the injury is usually severe and is the result of an external force, although a case has been reported due to the patient's falling down three or four steps. In this case the heel of the patient's shoe apparently caught on the step, causing marked plantar flexion, and the weight of the body forced the astragalus out anteriorly. The astragalus may be dislocated in any one of five positions: (1) medial; (2) lateral; (3) anterior; (4) posterior; and (5) rotary.

Skinner reports 2 cases. In the first, operation was performed in which it was necessary to free the astragalus from its attachments on all sides in order to restore it to its normal position. Triple arthrodesis was also performed. In the second the operative treatment was arthrodesis of the astragalonavicular and the calcaneocuboid joints. Skinner considers that the treatment in mediotarsal dislocations, as in dislocation of the astragalus, is immediate reduction. If not reduced, in these cases when seen later, it is impossible to do a closed reduction, due to thickened fibrous tissue. In the 2 cases he reports, arthrodesis of the involved joints appeared to be the treatment of choice and gave good results.—*R. S. Bromer.*

CASS, JEAN M. Staphylococcus aureus infection of the long bones in the newly born. *Arch. Dis. Childhood*, March, 1940, *15*, 55–60.

In this paper, the author reports 3 cases of *Staphylococcus aureus* infection of the long bones in the newborn. The condition is found to be compatible with good general condition and good ultimate prognosis, apart from the risk of

deformity, if the infection is unmixed and the lungs, skin, peritoneum and the meninges are not involved. Cass states that the study of the cases of this series supports the statements of Green and Dilliehunt that osteomyelitis of the long bones in infants is locally relatively benign and that, in uncomplicated cases, there is practically no systemic disturbance. The mothers of the patients sought advice because of the local swellings and not because the child seemed to be ill.

The roentgenographic findings in the 3 cases were confined for the most part to the femurs with marked periosteal proliferation, with rarefaction and some absorption of the metaphyseal areas. One patient also had marked absorption of the first metacarpal, right hand.

Repeated aspiration without open drainage gave good results and the lesions healed rapidly without sequestrum formation.—*R. S. Bromer.*

Ellis, Richard W. B., and van Creveld, S. A syndrome characterized by ectodermal dysplasia, polydactyly, chondro-dysplasia and congenital morbus cordis. *Arch. Dis. Childhood*, June, 1940, *15*, 65–84.

Ellis and van Creveld observed 2 children who showed association of four congenital abnormalities: ectodermal dysplasia affecting the hair, teeth and nails, polydactyly, chondrodysplasia and congenital morbus cordis. The clinical picture in the 2 patients is so strikingly similar that they feel justified in calling it a separate syndrome. They include in this paper a patient of McIntosh and Levine. In all 3 cases the roentgenograms showed short and thick long bones corresponding more or less closely to the classical picture of achondroplasia. In the first patient there was a tendency to exostosis in the region of the hips. In the third patient there was spur formation on the left tibia and irregular condensation at the distal end of each tibia, with fusion of the shaft of the fibula with the distal center of ossification of the tibia while the distal ends of each radius and ulna had a ragged, limiting boundary. This patient did not show hypotrichosis and congenital morbus cordis. In 2 of the patients there was some enlargement of the skull and depression of the nasal bridge, not altogether typical of achondroplasia. In each patient, a sixth digit was present on the ulnar side of the hand but the feet were unaffected.

In 2 of the 3 patients the parents were cousins. No similar condition could be found among the relatives. Ellis and van Creveld believe that the condition is a mendelian recessive without sex-linkage.—*R. S. Bromer.*

Walker, William A. Aseptic necrosis of bone occurring in caisson disease. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 1080–1084.

The subject of aseptic necrosis of bone occurring in caisson disease was reviewed by Kahlstrom, Burton and Phemister in 1939 and 4 cases were reported by them. They concluded that, in caisson disease, nitrogen bubble emboli in the blood stream caused infarction with subsequent aseptic necrosis of intramedullary bone. Since fat absorbs five times as much nitrogen as blood plasma, long bones were involved because of the higher fat content of the yellow bone marrow. The cortex was spared because of its rich blood supply. Later changes in the process following necrosis were reparative in nature. Within the shafts of the long bones the necrotic area was surrounded by a fibrous wall which went on to calcification and ossification. At the same time there was some replacement of dead bone by invasion of new bone. These processes went on until the strength of the bone had reached normal. When a weight-bearing epiphysis, such as the femoral head, was involved, there was early collapse followed by repair by means of new bone invasion and replacement, and calcification of non-substituted portions. Sections through the diaphyses revealed areas of grayish and brownish debris surrounded by an encapsulating wall of calcified fibrous material, while those through the head showed bone with areas of varying density but no areas of debris.

The case reported by Walker is in all respects similar to those reported by the previous writers. Roentgenograms were made of the entire skeleton. Those of the right hip revealed an irregularly flattened femoral head, throughout which there were numerous areas of decreased density surrounded by bone of increased density, lacking fine bone detail. There was some irregularity of the acetabulum corresponding to that of the head, and moderate narrowing of the joint space, with marked hypertrophic changes of both head and acetabulum. The diaphysis of the right femur, lower portion, revealed an irregular area, 4 inches in length, of uneven density, which was quite sharply demarcated distally and faded off proximally.

There was a similar shadow of increased density in the diaphysis of the upper right tibia, with a well-healed fracture at the level of the middle and lower thirds of the same bone. Within the medullae of the proximal phalanges of the right second, third, and fourth fingers there were several tiny areas of irregularly increased density and also a suggestion of irregular areas of decreased density in the cancellous bone. No other bones were involved.—*R. S. Bromer.*

HOOD, MARION, LAMBERT, CLAUDE N., and THOMAS, HENRY B. Hydatid cyst of the bone. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 986–991.

In their review of the literature, the authors found that over 480 cases of echinococcus disease have been reported from the United States, 19 of which were infected in this country. Of all the cases reported, 5 were echinococcus infection of the bone. Their patient was a Polish housewife, aged fifty-five. The roentgen examination at the time of admission showed irregular decalcification involving most of the left ilium. It extended upward from the acetabulum to the crest, limited medially by a narrow zone of normal bone with an irregular line of demarcation. Several linear radiolucent areas extended through it which suggested pathological fractures. Coarse trabeculation in the region of the anterosuperior spine suggested giant cell tumor as the primary lesion, but sarcoma, metastatic malignancy, and myeloma deserved consideration in differential diagnosis. At operation a cystic cavity was found which extended through both tables of the ilium. After removal of more bone the cavity was seen to extend downward into the roof of the acetabulum and the pubic ramus. Fluid from the cystic areas was examined for scolices and hooklets but none were found. A complement-fixation test gave a reaction of two plus.

The development of all hydatid cysts is a slow process. When such growth takes place in bony tissue, its progress is so retarded by the obdurate structure that years are required before it manifests itself. The patient kept a goat and a dog although she did not have the latter at the time of her illness. The extent of the growth would indicate, however, that she acquired the disease as a child in Poland rather than from recent contacts with these animals. —*R. S. Bromer.*

WASSERSUG, JOSEPH D. Tuberculosis of the greater trochanter and trochanteric bursae. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 1075–1079.

In this paper 18 cases of tuberculosis of the greater trochanter and the trochanteric bursae are analyzed. Fifty per cent of these cases had a history of local trauma and in 72 per cent there were one or more other demonstrable tuberculous foci. Five patients had the disease only in the trochanter and in 2 cases the bursae alone were involved, and there was no evidence of a trochanteric bone lesion.

When roentgenograms are made early in the disease, or when the bursae alone are involved, the roentgenogram may be of no assistance in making the diagnosis. In a few other cases, the roentgenographic study may be definitely misleading. Differentiation between tuberculosis of the trochanter and neoplasms of the femur is sometimes difficult. In the author's series roentgenograms revealed bone destruction in every case where the trochanter was involved. Occasionally, in obscure cases, the injection of a radiopaque substance into a sinus leads to a correct diagnosis. The diagnosis of tuberculous disease should be confirmed by bacteriological or histological methods or by both. Guinea pig tests should be made on all fluid obtained by aspiration, and on material draining from sinuses.

The radical surgical treatment is advocated by the author since it is preferable to prolonged conservative measures. Tuberculosis near the hip joint is serious because of its chronicity and the necessity for prolonged hospitalization.—*R. S. Bromer.*

GILL, A. BRUCE. Legg-Perthes disease of the hip: its early roentgenographic manifestations and its cyclical course. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 1013–1047.

In this paper Gill reports 13 cases of Legg-Perthes' disease with serial roentgenograms of each patient showing the roentgenographic course of the disease. In his summary he states that Legg-Perthes' disease is an affection of the head and neck of the femur which runs a cyclical course. The first, or degenerative, phase of the cycle extends through a period of approximately a year and a half. The second, or regenerative phase requires two or three years for its completion. Adequate treatment by pro-

longed non-weight-bearing shortens the cycle, and the absence of such treatment prolongs it.

The etiology is as yet unproved. The age incidence in Gill's cases was between three and eleven years, and 85 per cent were boys. Tuberculin reactions throughout were constantly negative and the blood sedimentation rate was normal. The usual symptoms were limp and pain which was more commonly felt at the knee. The disease was often far advanced at the onset of symptoms. The physical signs were limitation of motion (particularly of rotation) and a slight but definite, firm thickening of the hip. Occasionally a slight wasting of the muscles of the thigh was noted.

Gill regards the pathological process as essentially one of aseptic necrosis of the neck and head of the femur which is succeeded by a physiological process of repair. The necrosis is always evident in the metaphysis, and the study of the early cases indicates that the primary location of the disease is in this area. Necrosis of the head follows and the primary area in the head corresponds exactly to the primary area in the metaphysis. As the disease spreads in the metaphysis, corresponding changes occur in the remainder of the head. Healing occurs first in the metaphysis and later in the head. The corresponding part in each which was the first to to show evidence of necrosis is the first to repair. These observations indicate that the disease is essentially one which produces a progressive destruction of the blood supply through the metaphysis and the epiphyseal plate of cartilage, and that the changes which occur in the head are secondary to those in the neck. The deformities that arise in the head and neck are due to a mechanical crushing of the necrotic tissue caused by weight-bearing and muscle pull. Deformity of the acetabulum is dependent upon the altered shape and position of the head.

The areas of decalcification in the metaphysis of the femur due to early necrosis vary in number, size, shape, and location in the metaphysis. These irregular "holes" may first appear at the outer margin of the neck, or in the center, or, less commonly, at the inner margin. They may be small and irregularly rounded, or large and conical with the base of the cone upward against the epiphyseal plate. As time passes they multiply, enlarge, coalesce, and form a broad band across the entire metaphysis. Sometimes the band-like area of decalcification may be seen in the first roentgenogram made. If the roentgenograms are slightly overexposed, these areas stand out more clearly.

Treatment by rest in bed with Buck's extension leads to such complete restoration that in the final result it is difficult to detect any deformity of the head, neck, and acetabulum.—*R. S. Bromer.*

Compere, Edward L., Garrison, Monroe, and Fahey, John J. Deformities of the femur resulting from arrestment of growth of the capital and greater trochanteric epiphyses. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 909–915.

The authors present the results of their experimental work on animals, 27 goats, six weeks of age, to determine the effect of operative trauma in immature animals on the growth of the capital and greater trochanteric epiphyses. They concluded that surgical trauma to the greater trochanter of the hip of a growing animal, produced by multiple drilling or curettage of the epiphyseal cartilage plate, results in growth arrest with deformity and shortening of the greater trochanter. With this there is an associated coxa valga of the neck of the femur.

Surgical trauma to the epiphyseal cartilage plate of the head of the femur by multiple drilling or by curettage uniformly results in growth arrest, which produces a short femoral neck, an irregular contour of the head of the femur, coxa vara, and a functional shortening of the shaft of the femur, as measured from the articular surface of the head to the articular surface of the knee.

They believe, as a result of these experiments, that the operation of drilling the necks of the femurs of young children for the purpose of hastening revascularization of the head in cases of Legg-Calvé-Perthes' disease is a very questionable procedure. The contention of Bozan, Ferguson and Howarth, and others that drilling the neck of the femur, with extension of the drill into the femoral head, may hasten revascularization may be substantiated by the evidence which they present. When this procedure is used for fractures of the neck of the femur, Compere and his associates are not in disagreement with them. Drilling of the neck of the femur to promote healing after slipping of the femoral epiphysis may be justified if it does promote an earlier union between the capital epiphysis and the metaphysis of the neck. The average patient suffering from epiphyseolysis is at

least approaching the age of puberty and skeletal maturity. Furthermore, most of these patients do not recover completely, regardless of the type of treatment, until fusion and growth arrest take place.

The patient with Legg-Calvé-Perthes' disease, however, presents a very different problem according to the authors. Granted that the pathology includes septic necrosis of the capital femoral epiphysis and that the process of replacement by creeping substitution is exceedingly tedious, requiring two or more years, nevertheless any procedure which may produce growth disturbance in the femur of a young child should be considered radical and ill advised. The average age at onset of Legg-Calvé-Perthes' disease is approximately seven years. At this age most of the length growth of the bones has not yet taken place. The risk of deformity of the hip should be avoided by the surgeon who is charged with the care of a patient with a self-limiting disease.—*R. S. Bromer.*

HARRIS, H. W. Intrusion of the Smith-Petersen nail into the acetabulum. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 999–1003.

Harris presents 2 cases in which the Smith-Petersen nail was so firmly fixed in the cortex of the femoral shaft that, as the neck shortened, the nail penetrated the acetabulum. In the usual case, with similar femoral neck shortening, the nail has been extruded. In the first of Harris's cases he cannot explain the firm fixation of the nail. In the second case fixation was probably due to overgrowth of callus over the nail head. These 2 cases, and the observation that there is measurable shortening of the femoral neck in a large number of patients, point to the danger of mechanical fixation of the nail head to the femoral shaft. Such fixation has been advocated by several surgeons using various methods. Even when mechanical fixation has not been done, as in the 2 cases of Harris, he believes the possibility of perforation of the femoral head should be considered whenever a previously satisfactory nailing has become painful on motion.—*R. S. Bromer.*

GELLMAN, MOSES. Injury to intervertebral discs during spinal puncture. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 980–985.

Gellman reports the case of a syphilitic girl, aged fourteen, whose spine was first punctured on June 20, 1936, without any untoward effects. On September 4, 1936, she was subjected to several unsuccessful spinal taps. These were followed by immediate clinical manifestations of some local disturbance at the site of these taps. Lumbar hyperextension and severe pain were replaced within five weeks by lumbar flexion and prominence of the spinous processes of the second and fourth lumbar vertebrae. Roentgenograms on September 8, 1937, were interpreted as negative for any pathological condition of bone, but as time went on, subsequent examinations from October, 1937, until the final date of observation in April, 1939, gave evidence of narrowing of the affected joint spaces, compensatory widening of the adjacent joint spaces, and the development of the characteristic interarticular, intra-osseous Schmorl's nodules which are generally regarded as pathognomonic of intervertebral disc disturbance. The entire succession of events is so clear in this case that Gellman regards it as difficult to escape the conclusion that the described end-results followed the spinal puncture.—*R. S. Bromer.*

CARTER, RALPH M. Ollier's dyschondroplasia: report of a case. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 1063–1069.

The case reported by Carter is that of a man, aged forty-seven, with marked shortening, deformity and swelling of the lower right extremity. The roentgenographic examination showed diffuse mottling, apparently the result of abnormal calcium deposition, although some osteoporosis was also present, especially about the rim of the iliac crest. The condition extended into the acetabular region, and involved the right pubis and ischium. The upper end of the right femur was the site of a bulbous enlargement, with deformity of the neck and trochanteric region where there also was mottling. The shaft of the femur was very short, and the general shape of the bone, with another enlargement at the lower end, was that of a dumbbell. The same bulbous enlargement was seen in the upper end of the tibia. There was no periosteal reaction in the tibial growth and no calcification or other signs of extension into the surrounding tissues. The lower end of the tibia and the foot showed a similar appearance.

In the lower end of the femur, the process had apparently broken through the cortex, and numerous strands of calcification were to be seen extending out into the surrounding tissues, giv-

ing rise to a definite sun-ray appearance. The posterior portion of the calcaneum appeared cystic and here, too, the disease process had apparently extended into the surrounding tissues as shown by linear calcifications. Because of persistent pain and the deformity, disarticulation was performed at the hip joint. The patient is in excellent health, sixteen months after operation, and a recent roentgenogram shows no apparent change in the disease in the pelvis.

Carter considers this a case of Ollier's dyschondroplasia. According to Ollier's conception of the disease, it seems that it is not a true neoplasm in the strict sense of the word, but rather is the result of disturbance of the physiological processes of bone growth and development, due to undetermined factors. The deformities result from a retardation of growth of certain portions of a bone, with normal growth in other portions of the same bone. At the epiphyseal line, the cartilage proliferates normally, but normal degeneration and calcification, and therefore, ossification, are prevented. In consequence, as the bone grows in length, there persist in the diaphysis masses of unossified cartilage. Apparently as in Carter's case, these masses of cartilage may occasionally take on independent growth, until huge tumors are formed. Also, occasionally sarcomatous change may supervene.

From the roentgenograms of the lower end of the femur and of the calcaneum, it would seem that a malignant condition was present because the growth had broken through the cortex of the bone and had invaded the surrounding tissues. However, this opinion was not borne out by the examination of the tissues. The periosteum appeared to be intact in all the microscopical sections. The question can only be decided by the subsequent development of metastases. —*R. S. Bromer.*

Lapidus, Paul W. Sesamoids beneath all the metatarsal heads of both feet. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 1059–1062.

With a few extremely rare exceptions the adult human foot has two constant sesamoids beneath the first metatarsal head. Other foot sesamoids must be considered as inconstant. Lapidus records a patient with six sesamoids: the first tibial and fibular sesamoids, and the second, third, fourth and a fifth tibial sesamoid which were accidentally discovered in both feet of a woman, aged thirty-five, who was being treated for a strain of the right foot. Unfortunately no roentgenograms of her hands were taken.

Lapidus states that the more frequent occurrence of tibial sesamoids of the second, third, and fourth toes as compared with the extreme rarity of similar fibular sesamoids may be possibly understood if the location of these sesamoids in the tendons of the lumbricales is considered. These muscles run beneath the tibial aspect of the lesser metatarsal heads. The fibular sesamoids apparently fail to develop in human feet. However, this explanation fails to account for the presence of tibial and also fibular sesamoids beneath each metatarsal head in primates which have lumbrical muscles approximately similar to those in the human foot. Possibly the fibular sesamoids of lesser toes in primates are in the tendons of the interossei.—*R. S. Bromer.*

Haas, S. L. Growth following fusion for tuberculosis of the knee in children. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 1048–1053.

One of the arguments against treatment of tuberculosis of the knee joint in children by fusion or resection is the possible loss of growth in the extremity. If the epiphyseal cartilage plates of both the lower end of the femur and the upper end of the tibia are destroyed, there may be a loss of from 5 to 6 inches on the affected side.

Haas has had 12 cases of knee fusion in children. The age of the patients ranged from two and three-quarters to twelve and one-half years. In at least 3 of the patients there was a family history of pulmonary tuberculosis. The duration of the disease varied from one to ten years, being of greater duration in the older patients. The tuberculin test, guinea pig test, and microscopic findings were fairly uniform at the time of operation; and it is of interest that they were positive even in the older patients. It usually required two operations before a firm, osseous ankylosis took place. It required a longer period in the younger patients than in the older to secure ankylosis. The average time required for bony union in all patients was about two years. There was no loss of growth in the majority of the patients, and when it did occur it was no more than one-half inch. In some of the patients there was a lengthening after operation due to stimulation of the epiphyseal cartilage plate.

Haas concludes that arthrodesis of the knee joint for tuberculosis can be successfully per-

formed in growing children as young as two and three-quarter years without any loss of growth. Care must be utilized not to injure the epiphyseal cartilage plate. Adequate protection to prevent flexion deformity must be provided for several years after operation.—*R. S. Bromer.*

FERGUSON, ALBERT B. Treatment of osteogenic sarcoma. *J. Bone & Joint Surg.*, Oct., 1940, *22*, 916–922.

The author's first paper on this subject offered evidence that early amputation is not the best treatment of osteogenic sarcoma, and recommended delay of amputation with the use of irradiation, or excision, or both before amputation. The present paper gives further indications that early amputation is not the best treatment, and analyzes cases seen within two months of onset of symptoms to show that lack of haste in amputating improved results.

Early amputation is defined as amputation before the seventh calendar month after onset of symptoms.

Survivors are defined as patients alive more than five years after the last treatment of the local lesion with no evidence of tumor at the last report.

The cases studied are the first 400 cases of undisputed osteogenic sarcoma which had the necessary data for tabulation, recorded in the Registry of Bone Sarcoma of the American College of Surgeons. The favorable results obtained at various clinics or hospitals registering 10 or more cases included in this series appeared to be proportionate to their lack of haste in amputating. The higher percentage of survivors was obtained at the clinics having the higher percentage of late amputations.

Males and females had similar survival rates with each of the various types of treatment indicating that the disease was equally malignant in the two sexes. Early amputation was used more frequently in cases registered in later years as compared to the earlier years. The increase in early amputations was not accompanied by an increase in survivors. The campaign for earlier amputations resulted in an increase in very early amputations among the early amputations in the later periods of the Registry. Early amputations increased approximately 50 per cent, very early amputations approximately 100 per cent, but the survivors of early amputation decreased from 11.6 to 2.5 per cent.

Of the series, 82 cases were seen within two months of onset of symptoms and were treated by amputation. Amputation without previous irradiation yielded poor results in these cases. Neither site, age, variation in treatment, nor degree of malignancy estimated histologically explains the fact that the earlier amputations had the poorer results. In no case did the patient survive amputation in the first month after onset of symptoms. In no case did the patient survive early amputation if aged one to ten years or over twenty years. No patient survived early amputation if the lesion was not at the distal portion of the femur or the proximal portion of the tibia.

Ferguson states that the advocates of early amputation in osteogenic sarcoma of an extremity may persist in amputating as early as the third month after onset of symptoms if the patient is between eleven and twenty years of age, and has a lesion at the distal portion of the femur or the proximal portion of the tibia. However, in any other instance they can offer no tangible hope of success, and should therefore agree to the delay of amputation which does offer hope of success.

The best treatment to be used while amputation is delayed is still undetermined, but he offers the following measures with the choice depending upon the surgical feasibility of the operative procedures:

1. Irradiation.
2. Excision and irradiation.
3. Excision and implantation of bone graft of chips, with or without irradiation.

If excision is used, it should be repeated if recurrence becomes evident before amputation is performed. The interval between the last excision and amputation should not be less than three weeks, and probably should not exceed two months, if benefit is to be derived from combining the two treatments.

The optimum time for amputation is a quiet period in the course of the disease—a period when the patient is not losing weight; when the phosphatase content of the blood is not elevated; when there has been no sudden or marked increase in pain or swelling for two moths, and when there has been no recent marked increase of mass or destruction demonstrated roentgenographically. Such periods may occur with some frequency after the first six months of osteogenic sarcoma, and earlier in the course of the disease may be produced with the potent aid of irradiation.—*R. S. Bromer.*

Wilkins, Lawson. Epiphysial dysgenesis associated with hypothyroidism. *Am. J. Dis. Child.*, Jan., 1941, *61*, 13–34.

Epiphysial dysgenesis associated with hypothyroidism is manifested in roentgenograms by the appearance of multiple irregular islets of ossification in the cartilages scattered over a large area. These enlarge and coalesce to form an irregular, spongy, porous or fluffy mass. All centers of endochondral ossification may be affected. Wilkins found this abnormality in 23 of 25 hypothyroid children of whom roentgenograms were made at frequent intervals after treatment was begun. It was found not only in cartilages which already were ossified prior to thyroid treatment but also in those which began to ossify during the course of therapy. Only those centers showed dysgenesis in which the appearance of ossification had been delayed as a result of hypothyroidism. With continued treatment, ossification took place normally in those centers which ordinarily would not have been ossified at the age when therapy was begun.

Wilkins thinks that his observations suggest that in hypothyroidism a disturbance occurs in the cartilage in a stage just prior to the beginning of calcification.

In one hypothyroid child true osteochondritis deformans of one hip was found. This is a destructive lesion in a normally formed epiphysis and should be differentiated from epiphysial dysgenesis, which is an abnormality in endochondral ossification. Osteochondritis deformans and certain structural irregularities of the epiphyses may simulate epiphysial dysgenesis in a single roentgenogram. Wilkins has never found unquestionable epiphysial dysgenesis in any condition except hypothyroidism. He did not find it in dwarfs who did not have hypothyroidism even when they had delayed osseous development.

Although the primary factor in epiphysial dysgenesis is a disturbance occurring in the cartilage before ossification, the additional influence of mechanical forces and strains on certain of the abnormally formed epiphyses must be taken into consideration. The head of the femur and the navicular bone of the foot are the most important weight-bearing bones of the body. These parts show structural lesions which are more severe and persist longer than any others, irrespective of treatment. Dysgenesis was found more frequently in the head of the humerus and the femur than in any other location.—*R. S. Bromer.*

Evans, William A., Jr. Syphilis of the bones in infancy. *J. Am. M. Ass.*, July 20, 1940, *115*, 197–200.

Antepartum examinations and the treatment of syphilitic women during pregnancy have prevented many cases of syphilis in the offspring but have made the diagnosis of congenital syphilis even more difficult. In most cases the diagnosis is either finally confirmed or excluded by the serologic studies or by the roentgen examination of the long bones. A positive serologic reaction alone is of doubtful validity, for it is known that the property of producing a positive test may be transferred from the maternal blood to the fetal blood without the fetus being syphilitic (Filde's law). Christie has shown that if complement fixing antibodies are present in a nonsyphilitic child at birth, their concentration in the serum will rapidly diminish and disappear in about three weeks. A rise in the titer in a period of from four to six weeks will indicate a definite syphilitic infection. A negative serologic test in the newborn child is also inconclusive, for many children who eventually show evidence of syphilis have a negative serologic test at birth.

At the Children's Hospital of Michigan, routine roentgen studies of the long bones of premature infants and of infants in whom syphilis is suspected have been carried out for a number of years. Ingraham's observations indicate that from four to six weeks is required after the infection of the fetus for osseous lesions to appear. If this occurs early, i.e. in the fifth month of pregnancy, the lesions will be fully developed at birth. If the infection does not occur until shortly before birth, osseous lesions will not become manifest until the second or third month of life.

Bands of rarefaction or condensation are frequently seen at the ends of the diaphyses, especially in premature infants and those presenting nutritional disturbances. These changes cannot be regarded as specific. Periosteal shadows varying from the very find white line parallel to the shafts of the long bones to a very heavy onion-like cloaking of the bone are not pathognomonic of syphilis. Causes of these periosteal shadows are found not only in syphilis but also in subperiosteal fractures occurring at delivery, in rickets, in tuberculosis and other

forms of osteomyelitis, in hypertrophic pulmonary osteoarthropathy and probably as the result of nonspecific growth disturbances. In addition to the disturbance in calcification of the metaphysial areas in rickets, there is a failure of calcification of new bone laid down by the periosteum; this leads to an appearance of periosteal separation, or "cloaking," which closely resembles an inflammatory periostitis. True rickets is uncommon in the second or third month of life. At this age the roentgen manifestations are often atypical and may be confined to the shafts of the long bones with very inconspicuous changes in the metaphysial areas. In infancy osteomyelitis is rare but Caffey has reported cases of gonococcic and staphylococcic osteomyelitis with accompanying periostitis in infancy. Tuberculous involvement of shafts of the long bones is rarely seen. Extensive osseous and periosteal lesions may be seen. However, in tuberculosis, closely simulating syphilitic lesions, negative serologic reactions, a positive tuberculin test and failure to improve under antiluetic therapy favor the diagnosis of tuberculosis.—*S. G. Henderson*

DE BERNARDI, ETTORE. Raro caso di metastasi ossee da epitelioma cutaneo. (Unusual case of bone metastases of a skin epithelioma.) *Radiol. med.*, July, 1940, *27*, 579–580.

In 1932 a man, aged thirty-five, was slightly wounded by being struck beneath the right ear with a stone. After eight months an ulcer appeared in this region which was treated medically without success. When examined on April 24, 1934, there was a large ulcer surrounding the lower part of the right ear; it had irregular elevated edges and the base secreted a yellow liquid. It was painless. A diagnosis of epithelioma of the skin was made and confirmed by histological examination.

He was given fractional roentgen treatment, 5,760 r in sixteen days. He was readmitted October 25, 1937, with violent pain in the right hip. The epithelioma had healed with a thick, rigid scar, with only a small point where there was a bloody secretion. Roentgen examination showed serious bone lesions in the right pubis; there were extensive zones of destruction with islands of normal bone between them. The left pubis also showed an area of rarefaction at the symphysis. He was again given a total roentgen dose of 2,000 r.

In January, 1938, he still complained of pain. Roentgen examination showed a recent metastasis in the right acetabulum, while there were signs of recalcification of the metastases in the pubis. He was given another cycle of 3,600 r over the hip joint. In February he was much improved, had no pain and was able to walk. The right pubis was almost completely recalcified and in some places there was dense new-formed bone. The focus in the left pubis had disappeared.

In June, 1938, his general condition grew much worse; he was pale, almost cachectic and dyspneic. There was no pain in the pelvis. Roentgen examination showed specific infiltration in the upper third of the right lung. The patient died two months later. Autopsy was not permitted.

Bone metastases from a carcinoma of the skin are extremely rare. It might be held that the roentgen diagnosis of the bone foci was wrong and that they were ordinary osteomyelitic or tuberculous foci, particularly in view of the lung findings. But the author believes that the multiplicity of the foci, the clinical course of the disease and the course after roentgen treatment confirm his diagnosis. After the roentgen treatment there was an initial calcification followed by increased production of dense bone, as there is in healing after fracture with exuberant callus.—*Audrey G. Morgan.*